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TITLE: Brown Bear (*Ursus arctos*) Habitat Use and Food Resources on Elmendorf Air Force Base, Alaska

PRINCIPAL INVESTIGATOR: Sean D. Farley, Ph.D.
Herman Griese
Rick Sinnott
Jessica Coltrane
Chris Garner
Dave Battle

CONTRACTING ORGANIZATION: Alaska Department of Fish and Game
Anchorage, AK 99518

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Sean D. Farley, Ph.D., Herman Griese, Rick Sinnott, Jessica Coltrane
Chris Garner, Dave Battle

E-Mail: sean_farley@fishgame.state.ak.us

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14. ABSTRACT

Brown bears (*Ursus arctos*) are frequently observed on Elmendorf Air Force Base and the contiguous US Army's Fort Richardson military lands in Alaska. Effective bear management in this human-influenced area requires data on bear habitat use and numbers. We conducted a brown bear habitat and diet study on the military lands and adjoining habitats from 2005- 2007. Eleven bears (7F; 4M) were captured 15 times and outfitted them with Global Positioning System (GPS) radio collars to determine habitat and movement characteristics. Home range sizes were smallest for females with young ($\bar{x}$ = 113 km2; SD=51; n= 5), slightly larger for lone females ($\bar{x}$ = 231 km2; n = 2) and most expansive for adult males ($\bar{x}$ = 806km2; SD=811; n = 3). GPS data allowed us to identify critical travel corridors and to determine that the Glenn Highway is likely a barrier to bear movement. DNA-based identification of bears from hair samples collected along study area salmon streams identified 36 brown bears (26M; 19F) using habitat on military lands. Stable isotope ratios of 13C and 15N in bear hair bear determined the proportion of salmon, terrestrial meat, and vegetation/berries in their diet ($\bar{x}$ =37%; SD=19; $\bar{x}$ =34%, SD=16; $\bar{x}$ =30%, SD=11, respectively).

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Brown bear (*Ursus arctos*) minimum population count, habitat use, movement corridors, and food resources across Fort Richardson Army Post, Elmendorf Air Force Base, Campbell Tract area, and the Municipality of Anchorage, Alaska

Sean Farley[1], Herman Griese[2],

Rick Sinnott[1], Chris Garner[3],

Dave Battle[3], and Jessica Coltrane[1]

[1] Alaska Department of Fish and Game, 333 Raspberry Rd, Anchorage, Alaska 99518 Sean.Farley@alaska.gov;Rick.Sinnott@alaska.gov; Jessica.Coltrane@alaska.gov

[2] 3rd Civil Engineer Squadron. Environmental Conservation and Planning, 6326 Arctic Warrior Drive, Elmendorf Air Force Base, Alaska 99506-3240 Herman.Griese@elmendorf.af.mil

[3] US Army Garrison Alaska (Colorado State University-CEMML), 4500 Postal Service Loop, Fort Richardson, Alaska 99505 christopher.d.garner@us.army.mil; david.battle@us.army.mil

INTRODUCTION

Brown bears range in Alaska over most of the state; however expanding human presence and /or increasing bear densities can precipitate increasing human-bear interactions. Biologists and land managers often struggle with unintentional human-caused bear mortality. Managing these large predators in the face of human encroachment and diminishing or altered habitat is a challenging task.

Brown bears and signs of their presence are frequently observed on Elmendorf Air Force Base (EAFB) and the contiguous US Army's Fort Richardson (FRA) military reservation lands. Some or all of these bears also utilize habitat within the adjacent Anchorage Municipality (MOA) and Chugach State Park (CSP). The military reservation lands represent a strategic presence for the country's global defense mission, as well as provide essential training sites and recreational areas for thousands of military personnel. In addition, as natural areas in the MOA diminish, reservation lands are conditionally opened for civilian recreational use. Effective management of brown bears on the military lands and in the natural habitats of the adjacent MOA requires information on bear numbers, habitat use, and movements.

We began a project in 2005 to:

1. Determine brown bear habitat use through data collected from GPS (Global Positioning System) radio-collars placed on bears. Location data from the collars were expected to provide temporal and spatial patterns of bear movements and identification of travel corridors.

2. Identify as many individual brown bears as possible on military lands, using DNA-based identification procedures. This count will provide managers a minimum bear density on these military lands and surrounding areas.

3. Use stable isotope analyses to identify important diet items consumed by brown bears using military lands in the Anchorage area.

BODY

Methods

Bear captures, collar histories, and location data

Bears were collared with VHF spread spectrum technology radio collars equipped with GPS (Telonics, Inc, Mesa, AZ. USA) remote download capabilities. Springtime captures by helicopter were conducted on and near military lands as bears left their winter dens. Barrel trapping continued through the study on military lands at sites with previous bear use. All captures were conducted according to the Alaska Department of Fish and Game (ADFG) animal care and use policies. Collared bears were monitored periodically by aerial relocation.

Bear locations were collected and stored by GPS collars approximately once an hour. Bears were located by aircraft every two weeks, and archived data stored in the collar were uploaded to the aircraft. GPS collars were programmed to collect data for two summers. All but one collar were removed at the end of the study. Spatial analyses were conducted with ArcGIS 9.2 (ESRI, Redlands, CA. USA) and Hawth's Tools (Beyer 2004).

Brown bear numbers: Hair sample collection and analysis

Biological samples (hair, blood, and scat) were collected from all captured bears and from bears killed by hunters, by vehicles or in defense of life or property (DLP) in the study area. Additional hair was collected during visits to transects established in suitable bear habitat along salmon streams. Transects were located on EAFB, FRA, the North and South Forks of Campbell Creek, and the Snowhawk cabin trail of Ship Creek. The general areas for collection are identified in Figure 37. Samples were collected opportunistically from snagged hair on vegetation, known rub trees and small stakes coated with Catchmaster® glue (Atlantic Paste & Glue Co., Inc. Brooklyn, N.Y. USA)

placed along bear trails. The location and time/date of each sample were recorded. All samples were placed in coin envelopes with silica gel powder prior to extraction of DNA. DNA extracted from all samples provided species identification, gender, and individual identification of un-collared bears.

Brown bear numbers: DNA extraction, microsatellite loci selection, individual identification probabilities, and microsatellite genotyping

All laboratory analyses were conducted in the Molecular Ecology Laboratory of the Alaska Biological Sciences Center, USGS. The extraction procedure for genomic DNA described in Medrano et al. (1990) was used with modification. Two volumes of ETOH were replaced with 0.7 volumes of 2-propanol, 1% glycogen was introduced to the DNA precipitation step, and hairs were allowed to digest for 5 days. Extracted DNA was diluted to 50ng/uL to produce a working solution. Success of DNA extraction was quantified with fluoromety. Sterile procedures were followed and replications were checked for contamination by both positive and negative controls.

Recommendations from Paetkau (2003) and detailed methods as outlined in Jackson et al. (accepted) were followed for marker selection. As in Waits et al. (2001), individual identifications were assigned probabilities of identity ($P_{(ID)}$) such that chance of identical multilocus genotypes occurring between siblings or parent-offspring was restricted to between 0.01 and 0.0001.

Multiplexing various combinations of loci previously identified as useful for brown bear work produced a 6 loci multiplex with adequate resolution (Waits et al. 2001) for individual identification of bears in the Anchorage area ($P_{(IDobs)} = 9.447 \times 10^{-7}$; $P_{(IDsib)} = 6.776 \times 10^{-3}$). All individuals were then genotyped at each of 6 microsatellite loci, using methods outlined in Jackson et al. (accepted). Bears were assigned sex using markers described in Carmichael et al. (2005).

Brown bear diet: Stable isotope analyses

Bears maximize their opportunity to consume food items nutritionally important to their fitness. In Southcentral Alaska anadromous salmon, young ungulates, and berries are three critical elements of a bear's diet. Bears with access to coastal areas can also spend considerable time foraging on sedge grasses in the spring/early summer. While direct observations can be used to gather information on dietary habits, the potential for meaningful observations is low. Rather than relying upon behavioral observations of feeding, new techniques that exploit the isotopic nature of diet and consumer tissues have been developed. In particular, hair has been shown to reflect the diet of a consumer (Ben-David et al. 2004; Darimont and Reimchen 2002; Darimont et al. 2003).

Hair and blood samples were collected from all bears upon capture. Hair samples were detergent washed, triple rinsed in DI water, then washed 2X in 1:2 chloroform:ethanol solution and allowed to air dry overnight. Hair samples were macerated with scissors. Blood samples were vacuum freeze dried, then ground to fine particle size with a mortar and pestle.

Representative samples of local berries, moose, and salmon were collected during the summers of 2005 and 2007. Berries were gently cleaned of detritus in a water bath, and then dried to a constant weight in a vacuum freeze dryer. Dried berry pulp was separated from seeds. Pulp was ground with a mortar and pestle into a fine powder. Meat samples from fish and moose were freeze dried, then ground into a fine powder with dry ice with a mortar and pestle. All samples were loaded into small tin boats (ca. 2.0 mg of samples per boat).

Stable carbon and nitrogen isotope (^{13}C and ^{15}N) ratios were measured by continuous flow-isotope ratio mass spectrometry (Fry et al. 1992) using an elemental analyzer coupled to either a Micromass Optima or a Finnigan DeltaPlus XP mass spectrometer. All analyses were conducted at the USGS stable isotope facility at the Denver Federal Center, Denver Colorado. Hair and blood samples concentrations of ^{13}C and ^{15}N provide

information on bear diet (Hilderbrand et al. 1996; Phillips and Gregg, 2003). Samples were prepared in the ADFG lab in Anchorage, and the isotopic analyses were performed in the U.S. Geological Survey stable isotope lab in Denver, Colorado.

Isotopic discrimination occurs as a consumer metabolizes and assimilates diet items. Thus, isotope values of diet items were adjusted as in Ben David et al. (2004).

Two independent programs were used to calculate the percent of salmon, terrestrial meat, and vegetation in bear diets. IsoSource (Phillips and Gregg 2003; http://www.epa.gov/wed/pages/models.htm) determines all possible solutions to the equation describing isotopic values found in consumer tissues (hair), based upon the isotopic signatures of putative diet items. Outputs are couched in terms of percent diet item in the overall diet of the consumer. Stable Isotope Sourcing using Sampling (SISUS; http://statacumen.com/sisus/) utilizes a Bayesian approach to perform similar calculations. Isotopic values were measured in the hair of collared bears and in the berry, moose, and fish samples were inputs to both programs, and program outputs were compared.

Results

Bear captures

Eleven bears were captured a total of 15 times from 2005 to 2008 (Table 1; Figure 1). Nine captures occurred in 2005, four in 2006, one in 2007 and one in 2008. Seven females and four males were handled during the study. Reproductive status of females ranged from lone animals to those with three cubs of the year (COY). Automatic release mechanisms on all collars except two functioned as programmed by fall 2007. One of the remaining collars was recovered by recapturing the bear in spring 2008. In April 2008 it was determined that the last collar is either dropped in a maternity den or it is still on the bear. The collar location will be monitored during the spring of 2008 until well after normal den emergence.

Collar histories

Collar histories are summarized in Table 2. Equipment life varied considerably by animal, which is common when collaring bears. This study collected 22,906 raw data locations. Sample size for individual bears ranged from a few points (i.e., bear 203 a very large male wore his collar for only 4 days and 50 locations) to many locations (bear 200, re-collared multiple times, generated 4,879 locations).

Location data: Home ranges

The disparate location data collected across animals lent itself more to graphical depictions of home ranges and less to quantitative comparisons. Figures 2 – 13 show minimum convex polygons (MCP) for individual bears. One bear (#200) appeared to den on Elmendorf AB during 2007 – 2008. Beginning a theme that will be carried throughout this report, please note the overlapping confluence of multiple home ranges (Figures 2 & 14). The areas of high overlap include Ship Creek just upstream of the retention dam, and then several salmon streams in Bicentennial Park (Figure 14).

Figures 15 – 25 show the 95, 90, and 50 percent volume contours of home range area for each study bear. These contours were calculated from the kernel density estimations of home range determined by Hawth's Analysis tools extension for ArcGIS. Thus, the 95% contour for any bear represents a mean of 95% of the location data that were used to generate the kernel density estimate of that animal's home range. As the numbers suggest, the 95% contours approximate the maximal extent of each bear's home range.

Table 3 contrasts MCP home range areas (HRA) for each bear, stratified according to gender and reproductive status. Bear 203, a male, had only 50 data points and thus is not included with males 208, 209, and 211. Males had mean HRA of 806 km^2. Lone females had mean HRA of 231 km^2, while reproductive females had the smallest mean home range of 113 km^2.

Home ranges covered, and GPS locations included, strong evidence of salmon stream use by most bears. Females 204 and 206 both had cubs and showed strong use of salmon streams. However some lactating females (201, 205, and 210) spent very little time foraging on salmon streams, but rather essentially remained in one or two small valleys the entire season. In the fall all females returned to within several kilometers or less of the previous year's den site. Therefore, female bears observed at spring den emergence are likely to remain in the area if caring for young, and are likely to return to their general den area in the fall after the summer salmon runs. One male (#209) had den sites approximately 30 km apart between 2006 and 2007, whereas another adult male (#211) had den sites only a few kilometers apart during the winters of 2006 and 2007.

Location data: Distance(s) from streams and trails

The Geographic Information System (GIS) coverages for the MOA's Bicentennial Park (BCP), Campbell Tract (CT), and EAFB include salmon – spawning streams. In addition, unpaved trails that are either somewhat hardened ("major trails") or not hardened at all ("minor trails") are included in the GIS for BCP and CT (Figure 26).

The mean distances of bears 204, 207, 208, 209 and 211 from major and minor trails and from salmon streams (including bear 200), were calculated and summed by week. Figures 28 – 35 show data for unpaved trails and salmon streams.

When grand mean distances are calculated, individual variation masks any temporal trend lines. However it is clear that certain bears are highly reliant upon use of major and minor trails during the summer months. Bears 204, 207, 208 and 211 (reproductive female, lone female, and adult males, respectively) made extensive use of trails often frequented by people during the months of June, July, and a portion of August (Figure 27).

Except for bears 201, 205, and 210, most of the brown bears displayed a strong dependence on access to salmon streams (Figures 31-35); also supported by diet

information). Given that the distance measures are grand means summed over 7 day periods, the figures clearly depict that several bears maintain minimum distances of less than one kilometer to salmon streams for several week-long periods. Within any given day those bears often are less than 10 meters from streamside (not shown). Other studies (Farley et al. 2001; Flynn et al 2007) have identified patterns of brown bear stream use stratified by gender and reproductive status. In general, females tend to approach salmon streams perpendicular to the stream channel, possibly to minimize encounters with other bears. Males tend to patrol parallel to streams. In the current study bears on EAFB, FRA, and CT areas used human trails to access salmon streams, and bears were on or very near salmon streams when fish were present in the stream

Location data: Potential travel corridors

The GPS collars used in this study provide a track line of bear movements through time and space. The lines of travel in a given area can be visualized by connecting successive (in time) pairs of location points by a straight line. Figure 36 shows lines of travel for collared bears on EAFB and FRA lands.

Movements of larger animals on EAFB and FRA are constrained to the east by extensive fencing running parallel to the Glenn Highway and to some extent, highway traffic. The fence is designed to exclude moose from the highway right-of-way, and is essentially impassable to brown bears except for infrequent one-way gates and the lone underpass at the intersection of Ship Creek and the Glenn Highway. Bears can enter and exit EAFB and FRA lands from the east via Eagle River and Ship Creek bridges, or across the Glenn Highway around the eastern end of the fence or (less likely) through the one-way gates.

On military lands northwest of the Glenn Highway the largely undeveloped section east of the EAFB airfield and west of the FRA cantonment area forms a natural corridor between Ship Creek and the northern undeveloped portion of the installations, including Sixmile Creek. This corridor holds two fenced ammo storage areas which deflect bear movement, but the remainder has sparse development with an encroaching gravel pit

development on the west. The heavy spruce component in this zone apparently provides attractive cover and security. Bears typically exploit undeveloped areas for travel corridors, even if bounded by human developments, and collared bears in this study used this travel corridor east of the EAFB airfield (Figure 36).

Riparian zones are recognized as natural movement corridors for animals, and Ship Creek is especially attractive to bears as it has salmon in its lower reaches. However, a bear on Ship Creek west of the Glenn Highway has limited travel options as the south side of the stream contains housing and industrial development. Thus, bears moving in the Ship Creek riparian area can either travel east via the only Glenn Highway underpass, or return to the north through the corridor east of the EAFB airfield, or circle through the urban areas of the MOA west of the fence. There were few location data indicating collared brown bears crossing under the highway and no location data indicating bears moving through the urban areas, although sightings of brown bears from previous years indicates this does sometimes occur (Figure 36. Wildlife cameras positioned and maintained by FRA during the later year of the study have recorded only black bear crossing under the Ship Creek Bridge on the Glenn highway.

Though Ship Creek rarely has salmon in its middle reaches due to the EAFB water intake dam obstructing salmon passage, bears are attracted to this stretch of creek (Figure 36). It is assumed to be a travel corridor, to provide access for springtime hunting of moose calves, or as temporary holding area to launch downstream feeding trips through the Eagleglen Golf Course to feed on salmon held up by the dam. This corridor becomes very restrictive the further downstream a bear travels, nevertheless at least one collared bear recorded locations downstream of the Elmendorf fish hatchery. Though most fish are stopped downstream at the hatchery, the olfactory attraction is likely very strong for bears. As long as anadromous fish are present, brown bears will continue to frequent Ship Creek. Unfortunately, increased human residential development, coupled with a desire to increase salmon presence on Ship Creek, will likely lead to increased numbers of bear-human interactions.

Bears tend to follow watersheds and geographic boundaries, such as the Knik Arm bluff and the edges of the Eagle River Flats. The Knik Arm bluff from the Port of Anchorage north across the Eagle River Flats is heavily used by bears (Figure 36), as are both the north and south forks of Campbell Creek. Bears apparently use these areas in the spring looking for moose, and tend to remain in the area through the duration of the salmon runs.

In summary, the Glenn Highway and associated fencing is a significant barrier to brown bear movement from mountain den sites and alpine-subalpine berry patches to lower elevation areas with coastal flats, moose and salmon. This corridor disruption is reflected both in the lines of travel constructed from GPS locations (Figure 36), and in the apparent lack of movement of bears across the Glenn Highway as seen from identification of individual bears from DNA hair samples (see below).

Brown bear numbers: Hair sample collection and analysis

Hair sampling was conducted during 2005, 2006 and 2007 at established sites. Samples were collected on FRA from bear trails along the north forks of Campbell Creek and Chester Creek and their intersections with the Bulldog Trail, from rub trees identified on the Snowhawk cabin trail, and from Moose Run Golf course. Samples were collected on EAFB along bear trails on Sixmile Creek, at various garbage dumpster sites near recreational chalets, and near Otter Lake. Additional samples were collected on rub trees and bear trails identified on the north and south forks of Campbell Creek in BCP and CT. Hairs were also collected from bear trails at Potter Marsh and Bird Creek. Miscellaneous samples from the Anchorage area were provided by ADFG.

Brown bear numbers: DNA - based identification

A total of 446 hair samples were collected and analyzed, identifying 29 brown bears (10 females, 19 males) across the sampling sites (Table 4, Figure 37). Combined with data from earlier (2005, 2006) bear capture work, 36 individual brown bears (15 female; 21 male) were identified in the study area (Table 5). The 36 bears may include bears as

young as COY, though the long guard hairs and the height at which hairs are left are indicative of animals older than COY.

Not all collared bears were also identified in hair samples from the study area. Hair from bears 201, 205, 206, and 210 was likely not collected because their home ranges did not intersect areas of hair sampling. However it was surprising that hair was not collected from bears 207 and 208 as collar location data clearly show these bears using areas of hair sampling. This sampling inconsistency highlights the fact that the number of bears identified from DNA and captures (36) is not a complete population estimate with an error range, but instead is a minimum population count of bear presence. This distinction means that undoubtedly the true population of bears using the study area is larger than 36 individuals, but how much larger is unknown.

Fifteen individual bears were identified using military lands, but not all bears used the land exclusively. Eight bears were identified only from samples collected on military land and no record of their presence was detected from samples collected on non-military lands (Table 5). Five other bears found on military lands were also determined to be using Campbell Creek to the south. Lastly two additional bears used both military land and non-military lands to the northeast of FRA along the coast. One of these bears (#209, an adult male) traveled up to 25km to the east, 25km to the northeast and across Knik Arm from military lands.

There were 20 individual bears identified within the MOA, primarily BCP, CT and south Anchorage (Table 5; Figure 37). Fifteen of these animals were not identified from samples collected elsewhere, and five were the same five bears observed on military lands as well (see previous paragraph). The remaining eight bears (36 – (15+8+5)) reflect incidental captures and samples from problem animals in the area.

The segregation of bears into groups suggested from the hair sampling data reaffirms that the Glenn Highway limits bear movements from EAFB and FRA lands west of the Glenn Highway to BCP and the CT area.

Brown bear diet: Stable isotope analyses

Diet and hair isotope values are depicted in Figure 38. Predicted diet compositions are presented in Table 6.

Both programs (IsoSource and SISUS) provided similar results for all runs. General expectations for potential diets of individual bears based upon GPS locations were supported by isotope data. Home range data for bears 201 and 205 (Figures 4, 7, 16, & 19) showed little visitation to streams with salmon. Stable isotope predictions showed both these bears with the lowest fraction of salmon in the diet. Excluding bears 201 and 205, the average diet composition was: Salmon 43 %; Terrestrial meat 29%; Vegetation and berries 27%. While the isotope discrimination did not have the power to identify marine vegetation in the diet, coastal brown bears are known to consume sedges. The Eagle River Flats has abundant sedge habitat, and it was visited frequently by bear 200.

Clearly, salmon are an important resource for brown bears in this study and thus require and seek access to streams when salmon are present. The nutritional ecology of brown bears is well documented to include a large salmon component (Hilderbrand et al 1999, Rode et al. 2006a, b; Rode et al. 2007; Fortin et al. 2007; Flynn et al. 2007).

It is important to recognize that the diet calculated from isotopes measured in bear hair reflects food intake during hair growth (i.e., early June through September). Our understanding of classical Alaskan predator prey relationships supports the interpretation that the terrestrial meat measured in the diet of these study bears likely came predominately from eating moose calves and the occasional yearling/adult. However within EAFB and FRA, and more recently, within parts of CSP near the city, bears gain access to scores of moose gut piles and carcasses from September through November

from animals harvested by hunters. Thus it is likely that moose hunting in the study area provides an important component of total terrestrial meat consumed by these study bears.

KEY RESEARCH ACCOMPLISHMENTS

1. The largely undeveloped section east of the EAFB airfield and west of the FRA cantonment area forms a natural corridor between Ship Creek and the northern undeveloped portion of the installations, including Sixmile Creek.

    a. The Glenn Highway and associated fencing is a significant barrier to brown bear movement.

2. The study area was used by at least 36 individual brown bears (15 female; 21 male).

3. Salmon are an important resource for brown bears in this study and thus require and seek access to streams when salmon are present

REPORTABLE OUTCOMES

Presentations and manuscripts in preparation

Farley, S., R. Sinnott, J. Coltrane, H. Griese, W. H. Clevenger and C. Garner. 2006. Brown bear (*Ursus arctos*) habitat use and food resources on Elmendorf Air Force Base and Ft. Richardson Army Post, Alaska, DOD Natural Resources Training Workshop; National Military Fish and Wildlife Association, Columbus, Ohio

Griese, H., S. D. Farley, W. Clevenger, C. Garner, R. Sinnott and J. Coltrane. 2006. Alaska Brown bears in our midst: Alaskan brown bear in habitat refugia of Elmendorf Air Force Base and Fort Richardson Army Post, and on salmon streams in city parks of Anchorage, Alaska, 13th Annual Conference of The Wildlife Society, Anchorage, Alaska

Farley, S. D, R. Sinnott, J. Coltrane, H. Griese, C. Garner and D. Battle. 2008. Alaskan brown bear (*Ursus arctos*) on Elmendorf Air Force Base, Fort Richardson, and urban areas of Anchorage, Alaska. DOD Natural Resources Training Workshop; National Military Fish and Wildlife Association, Phoenix Arizona

Farley, S., H. Griese, R. Sinnott, J. Coltrane, C. Garner and D. Battle. (*In prep*).Characteristics of an urban brown bear population. For submission to J. Wildlife Management.

CONCLUSIONS

Management Implications

One of the most startling findings of the study is that large numbers of brown bears are foraging, rearing young, and denning in close proximity to human development and human presence. Brown bears will utilize travel corridors that are in close proximity (less than 1 kilometer) to the EAFB airfield that services advanced fighters (F-22A) as well as some of the large military transport aircraft (C-17 Globemaster). Yet, brown bears appear reluctant to cross underneath a 4-lane highway through a small bridge underpass on Ship Creek. In all likelihood the differing amounts of hiding cover available and the proximity and constant movement associated with passing traffic are important factors in a bear's decision to travel through an area.

Brown bears are apparently very good at being secretive in their activities as evidenced by the unexpectedly high number of bears using military lands, BCP and private lands near the Chugach foothills within the MOA. The presence of many bears attracted to seasonal food concentrations (i.e., moose calves and salmon), coupled with expanding development along salmon spawning streams, and increasing human activity in parks and other natural areas, will increase the probability of bear-human interactions occurring. Increasing human presence, whether through recreation, military training, transportation corridor developments, or other activity or development, will require thoughtful planning to minimize the risks to human safety and long-term impacts to the bear population.

Cook Inlet waters are not a barrier to bears. Both black and brown bears have been observed successfully crossing Turnagain and Knik Arms. The home range of one male in this study extended from the headwaters of Peters Creek to the little Susitna River. Adult male brown bears have large home ranges, and this study demonstrated that it is reasonable to expect bears to travel to military and MOA lands for food and in pursuit of mates from the west side of Knik Arm, from CSP, and across multiple game management units.

Brown bears in this study denned at elevations ranging from 1500 to 4200 ft above sea level, and several dens were visible from downtown Anchorage. It is very likely that a collared adult female denned on Elmendorf AB within a few kilometers of the runway (verification of the den site is delayed until after late May 2008). Both males and females traveled from den sites in the mountains of CSP down to sea level for food. Salmon are found in Sixmile, Ship, Chester, Rabbit and Campbell Creeks, and Eagle River. These bears then travel between the lower portions of the creeks and portions of CSP as they forage.

How many bears should be tolerated sharing streams and trails with humans is a difficult question. However any effort to reduce the number of bears through hunting or other lethal means will need to be a continuous program as there are ample resources in CSP and across Knik Arm to provide for constant immigration of bears.

Brown bears and humans have co-existed on military and MOA lands for many years, and the number of maulings and human fatalities is low. However the importance of salmon in the diet of brown bears pointedly suggests that redistributing and/or increasing the presence of salmon in military and MOA area streams will re-distribute the presence and/or increase the number of brown bears using those same areas. For example, enhancing adult salmon passage on Ship Creek has the potential to concentrate bears near golf courses, family housing and several picnic areas on the military lands. The risk to human safety needs to be evaluated and a strategy developed to minimize the risk of bear-human interactions. One proposal would be to develop a predictive model of potential bear feeding sites along Ship Creek and Campbell Creek. The model could be tested by monitoring the fate of tagged fish as they proceed upstream. Creek stretches showing high use by bears catching tagged fish could be identified as sites with high risk for bear-human encounters. Appropriate trail designs could incorporate this information such that sections of streams would not have easy human access. Bears would likely tend to those sites more than others.

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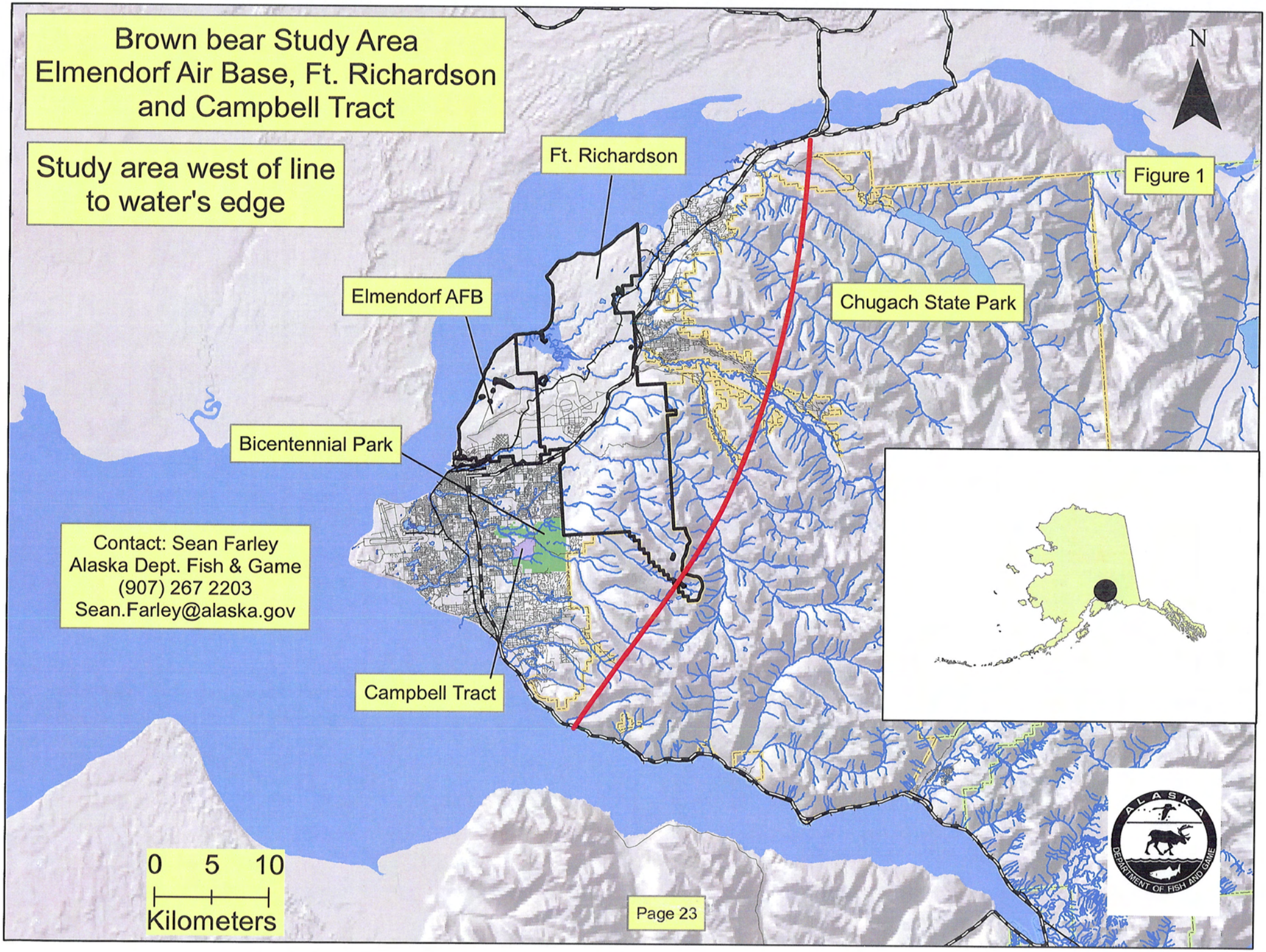
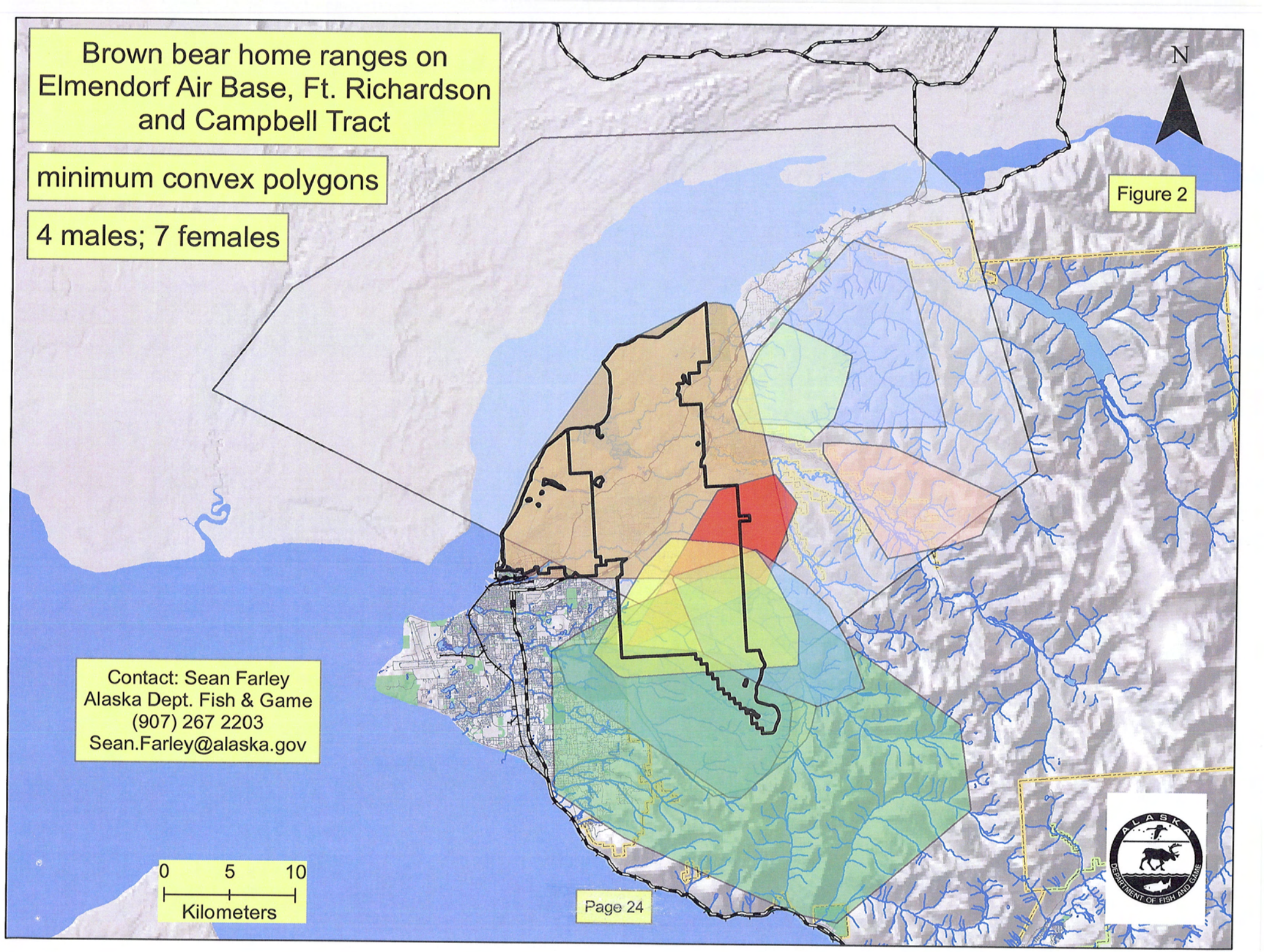
APPENDICES
Figures and Tables


Brown bear Study Area
Elmendorf Air Base, Ft. Richardson
and Campbell Tract
Study area west of line
to water's edge
Ft. Richardson
Elmendorf AFB
Bicentennial Park
Campbell Tract
Chugach State Park
Figure 1
N
Contact: Sean Farley
Alaska Dept. Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
0 5 10
Kilometers
ALASKA
DEPARTMENT OF FISH AND GAME


Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
minimum convex polygons
4 males; 7 females
N
Figure 2
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Alaska Dept. Fish & Game
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Sean.Farley@alaska.gov
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Kilometers
Page 24
ALASKA
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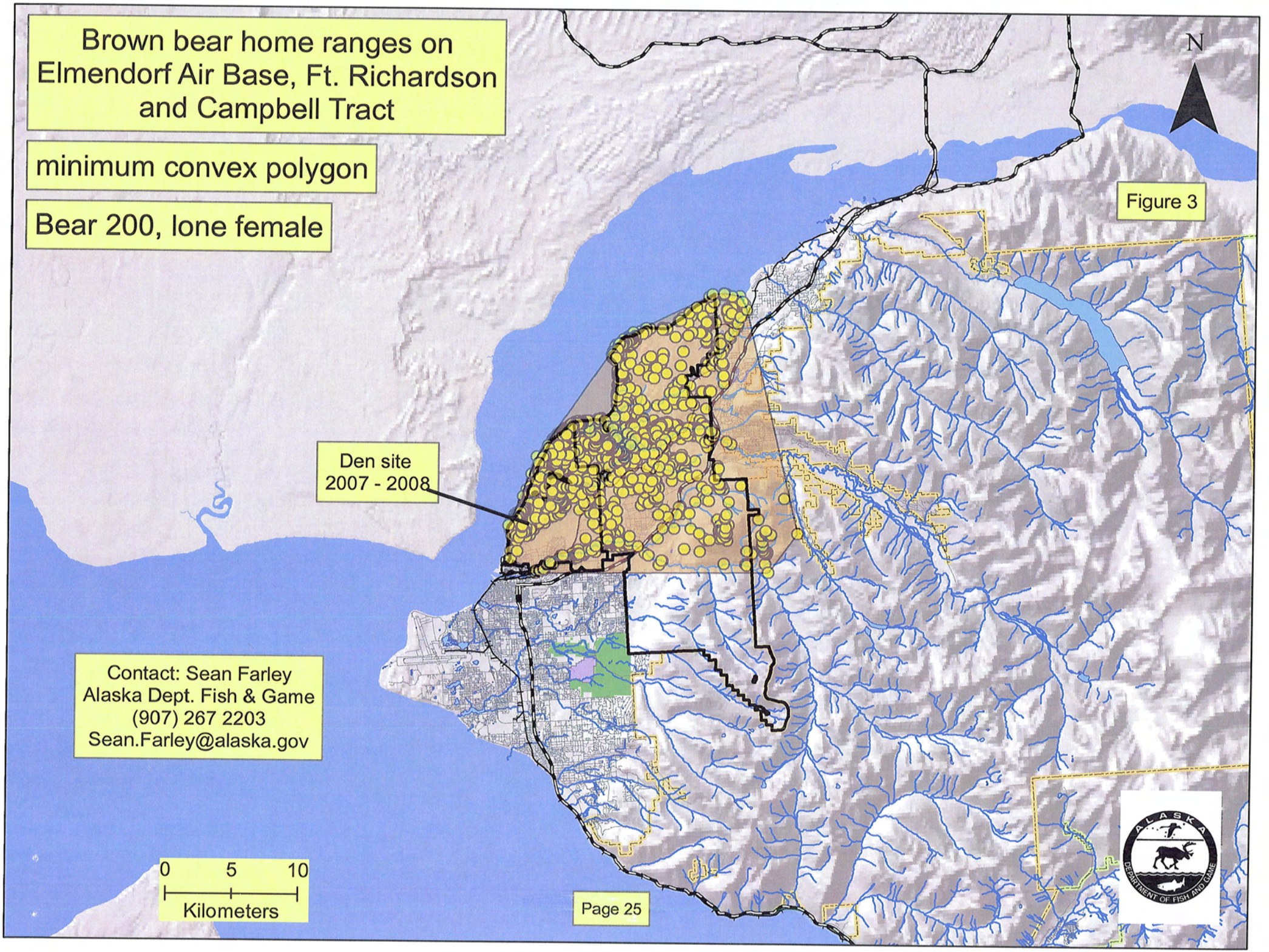
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
minimum convex polygon
Bear 200, lone female
N
Figure 3
Den site 2007 - 2008
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Alaska Dept. Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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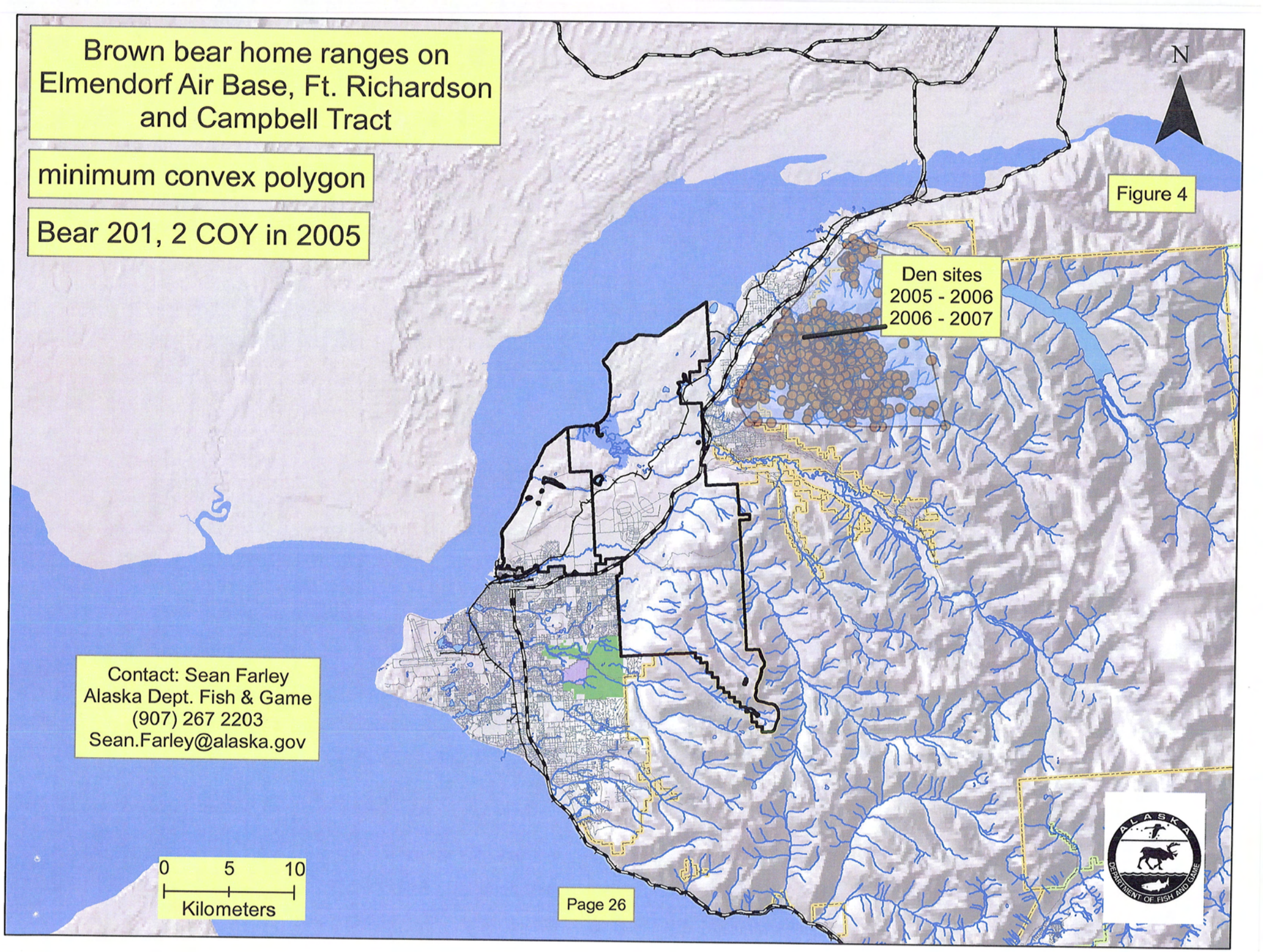
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
minimum convex polygon
Bear 201, 2 COY in 2005
Figure 4
Den sites
2005 - 2006
2006 - 2007
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Contact: Sean Farley
Alaska Dept. Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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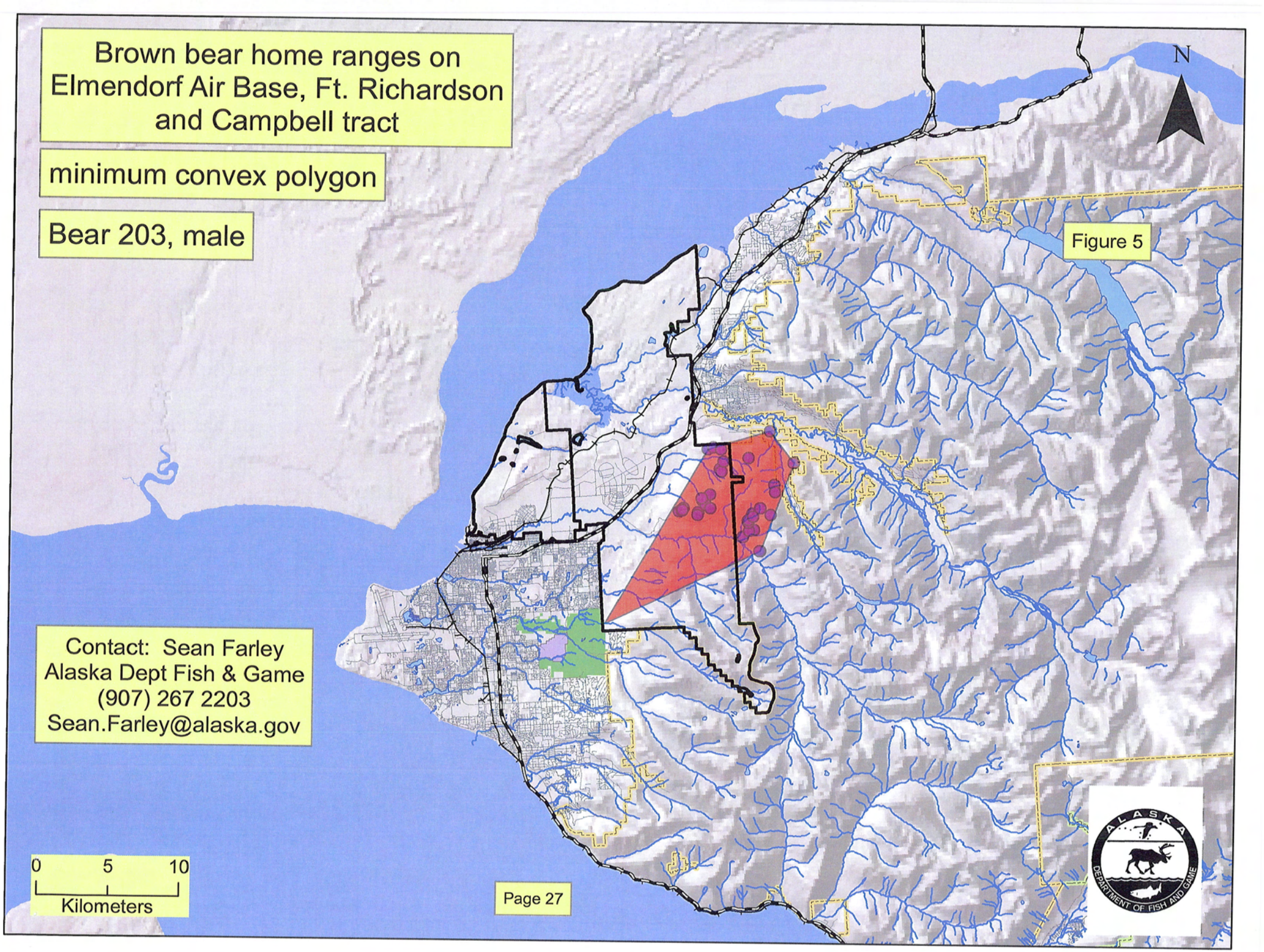
Brown bear home ranges on
Elmendorf Air Base, Ft. Richardson
and Campbell tract
minimum convex polygon
Bear 203, male
N
Figure 5
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Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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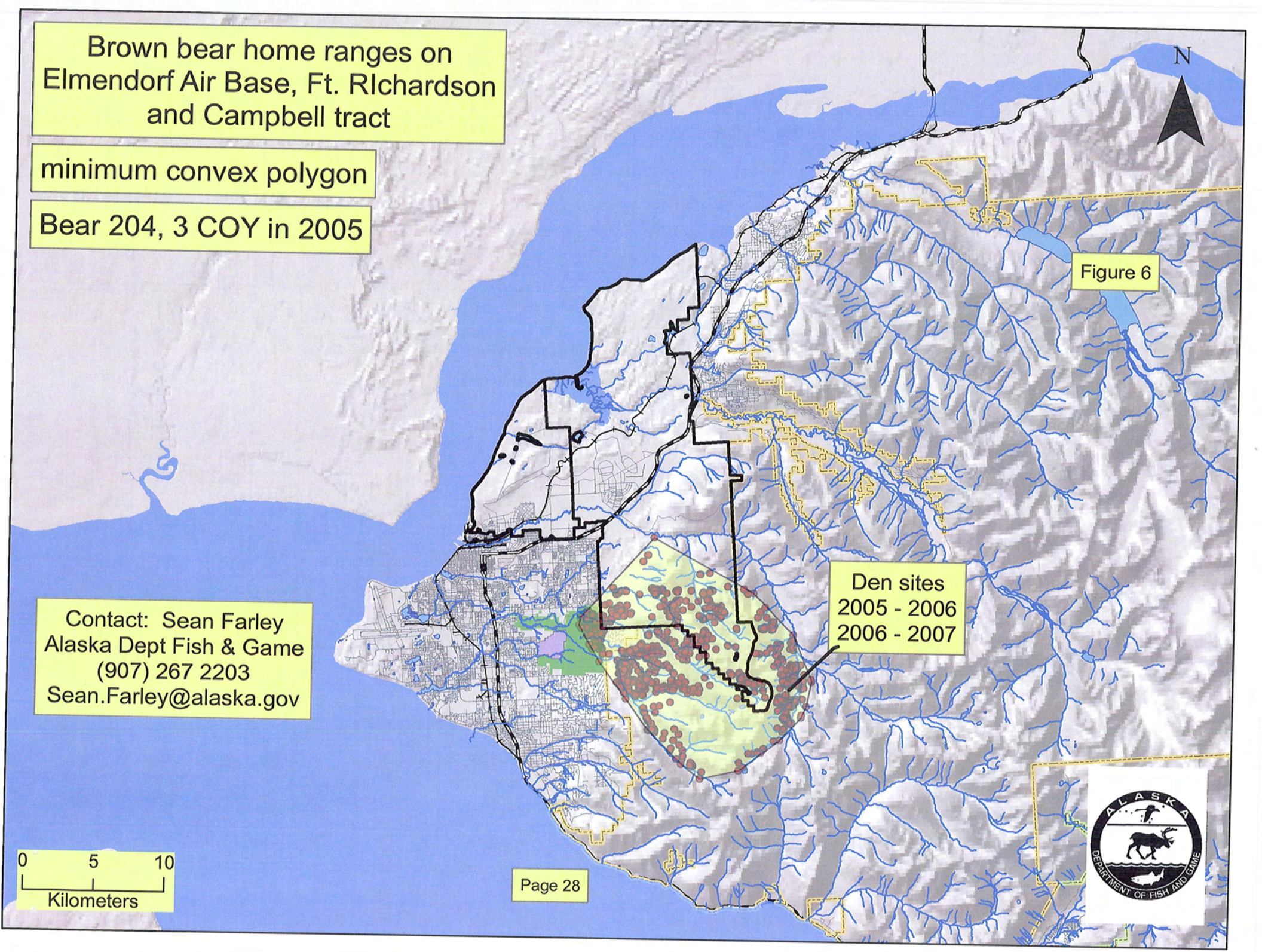
Brown bear home ranges on
Elmendorf Air Base, Ft. RIchardson
and Campbell tract
minimum convex polygon
Bear 204, 3 COY in 2005
N
Figure 6
Den sites
2005 - 2006
2006 - 2007
Contact: Sean Farley
Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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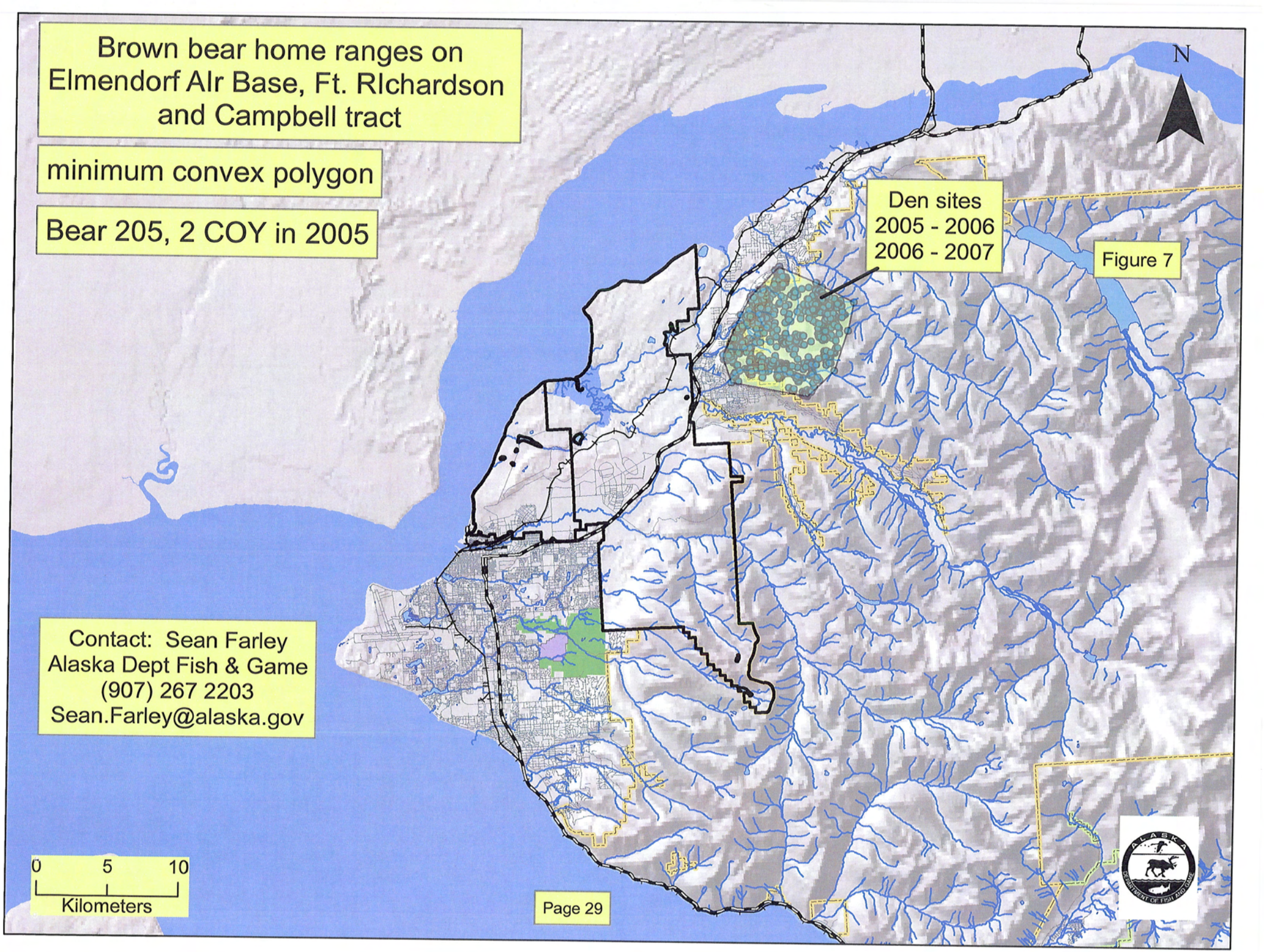
Brown bear home ranges on
Elmendorf Alr Base, Ft. RIchardson
and Campbell tract
minimum convex polygon
Bear 205, 2 COY in 2005
Den sites
2005 - 2006
2006 - 2007
Figure 7
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Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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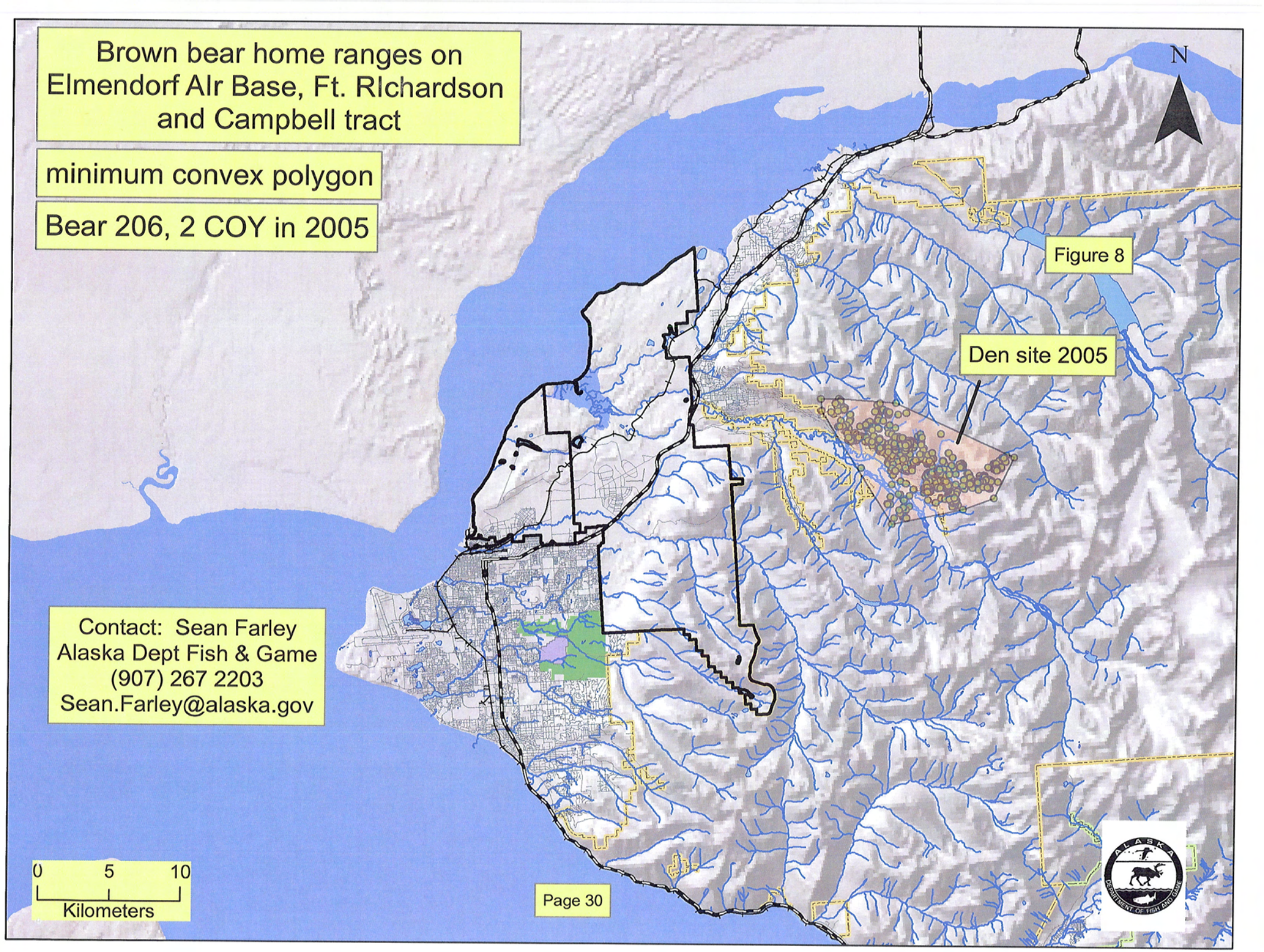
Kilometers
Page 29


Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell tract
minimum convex polygon
Bear 206, 2 COY in 2005
N
Figure 8
Den site 2005
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Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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Kilometers
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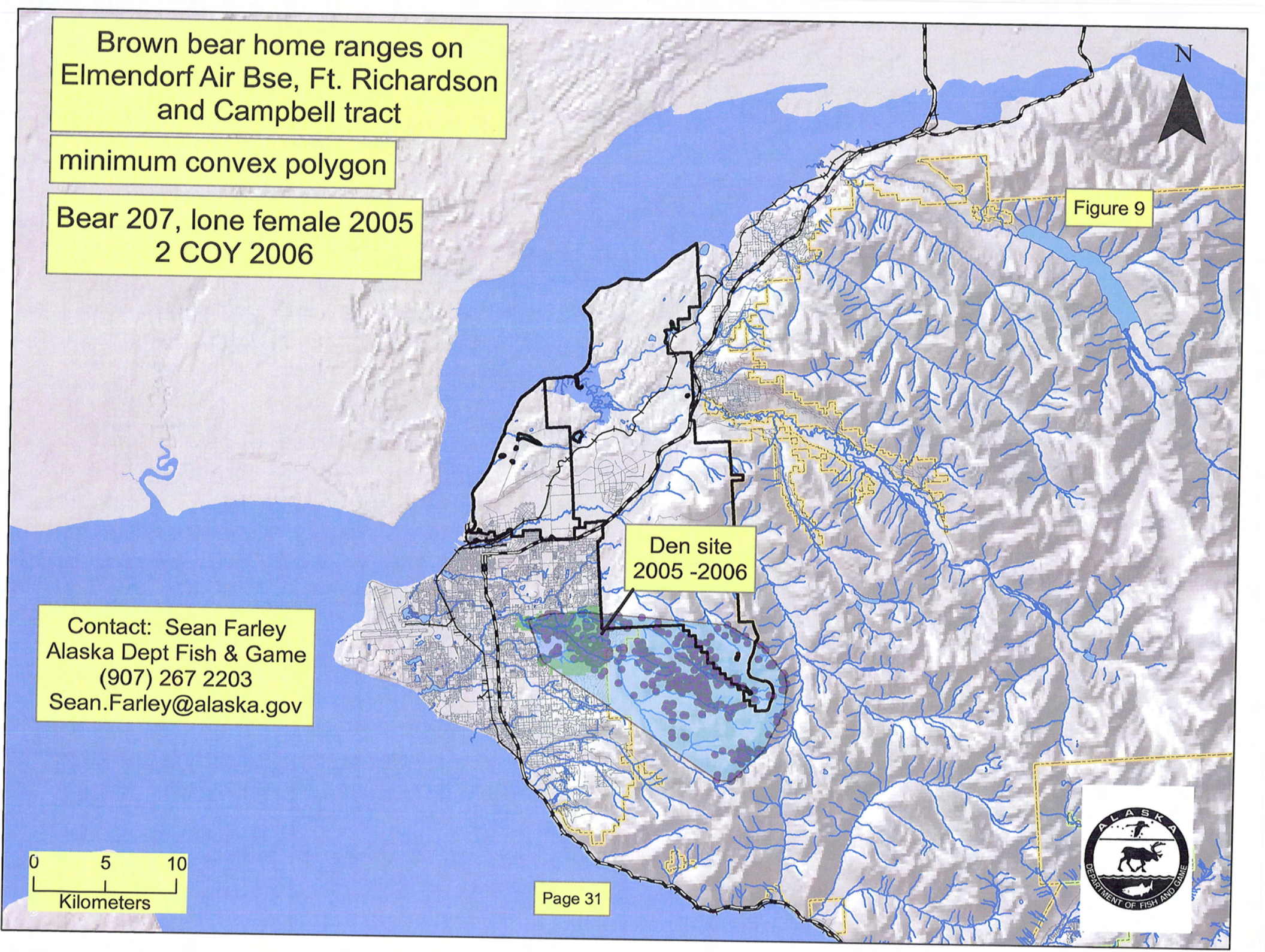
Brown bear home ranges on Elmendorf Air Bse, Ft. Richardson and Campbell tract
minimum convex polygon
Bear 207, lone female 2005
2 COY 2006
N
Figure 9
Den site
2005 -2006
Contact: Sean Farley
Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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Kilometers
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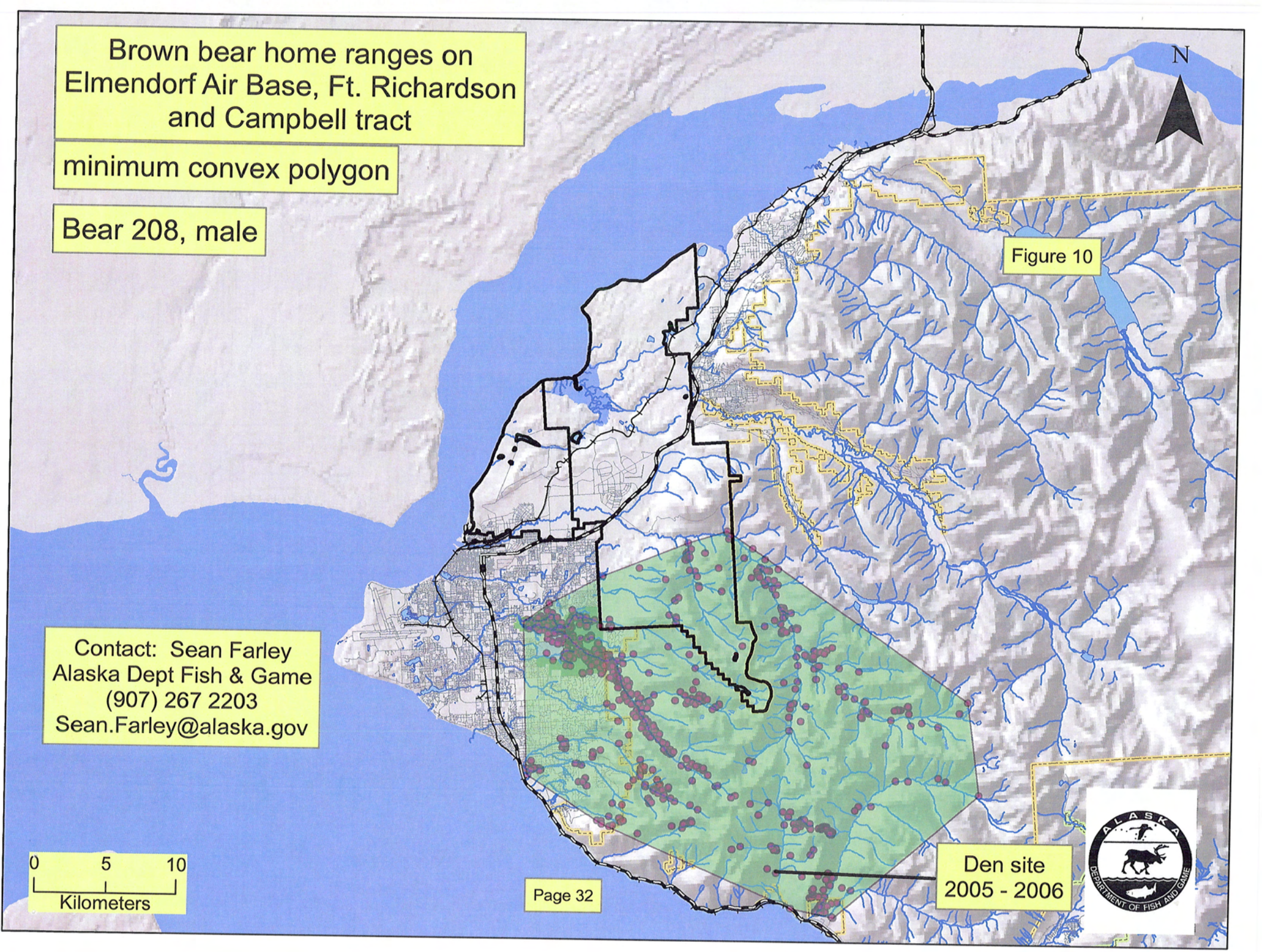
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell tract
minimum convex polygon
Bear 208, male
N
Figure 10
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Alaska Dept Fish & Game
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Sean.Farley@alaska.gov
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Kilometers
Page 32
Den site 2005 - 2006
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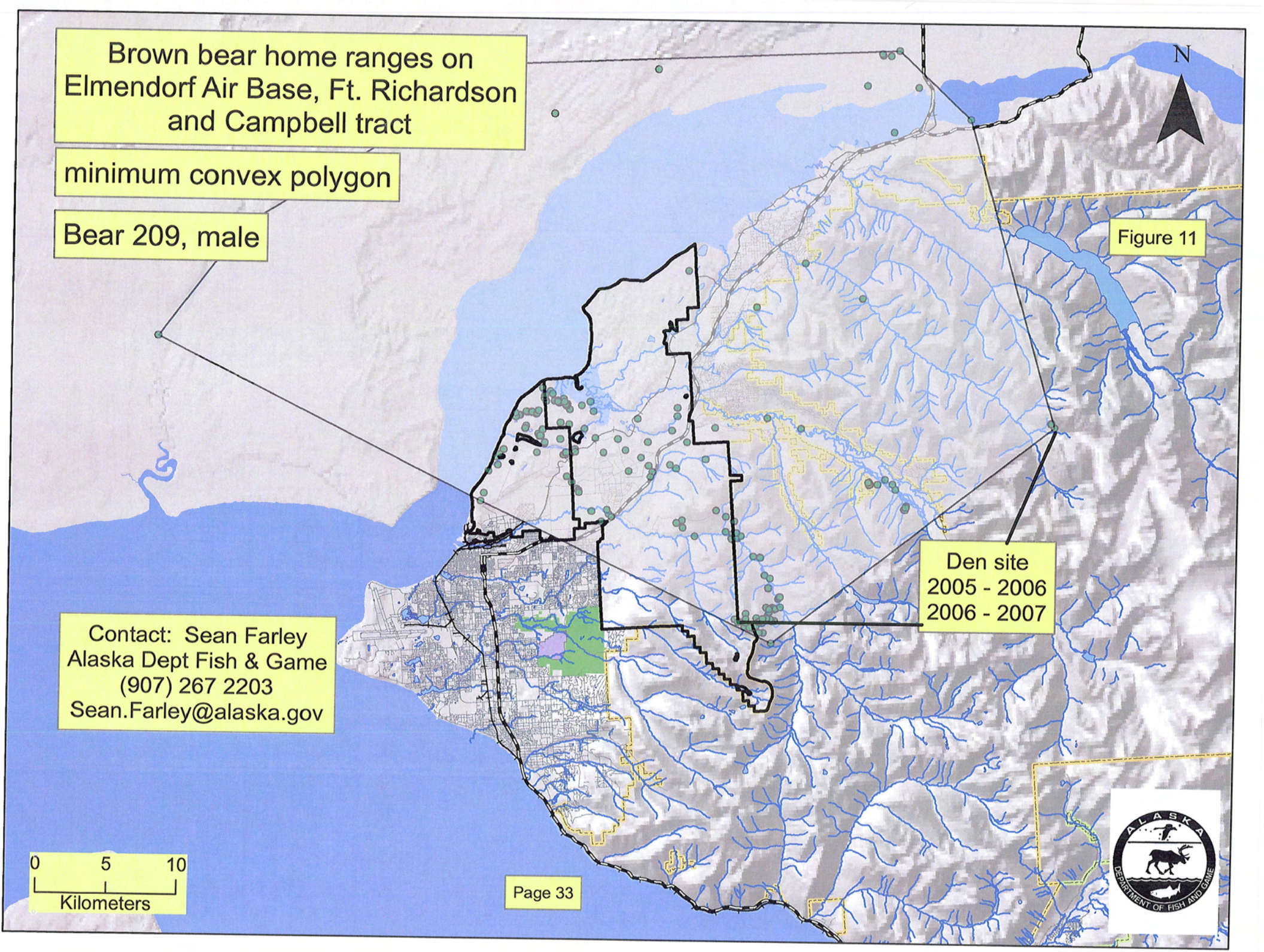
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell tract
minimum convex polygon
Bear 209, male
N
Figure 11
Den site
2005 - 2006
2006 - 2007
Contact: Sean Farley
Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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Kilometers
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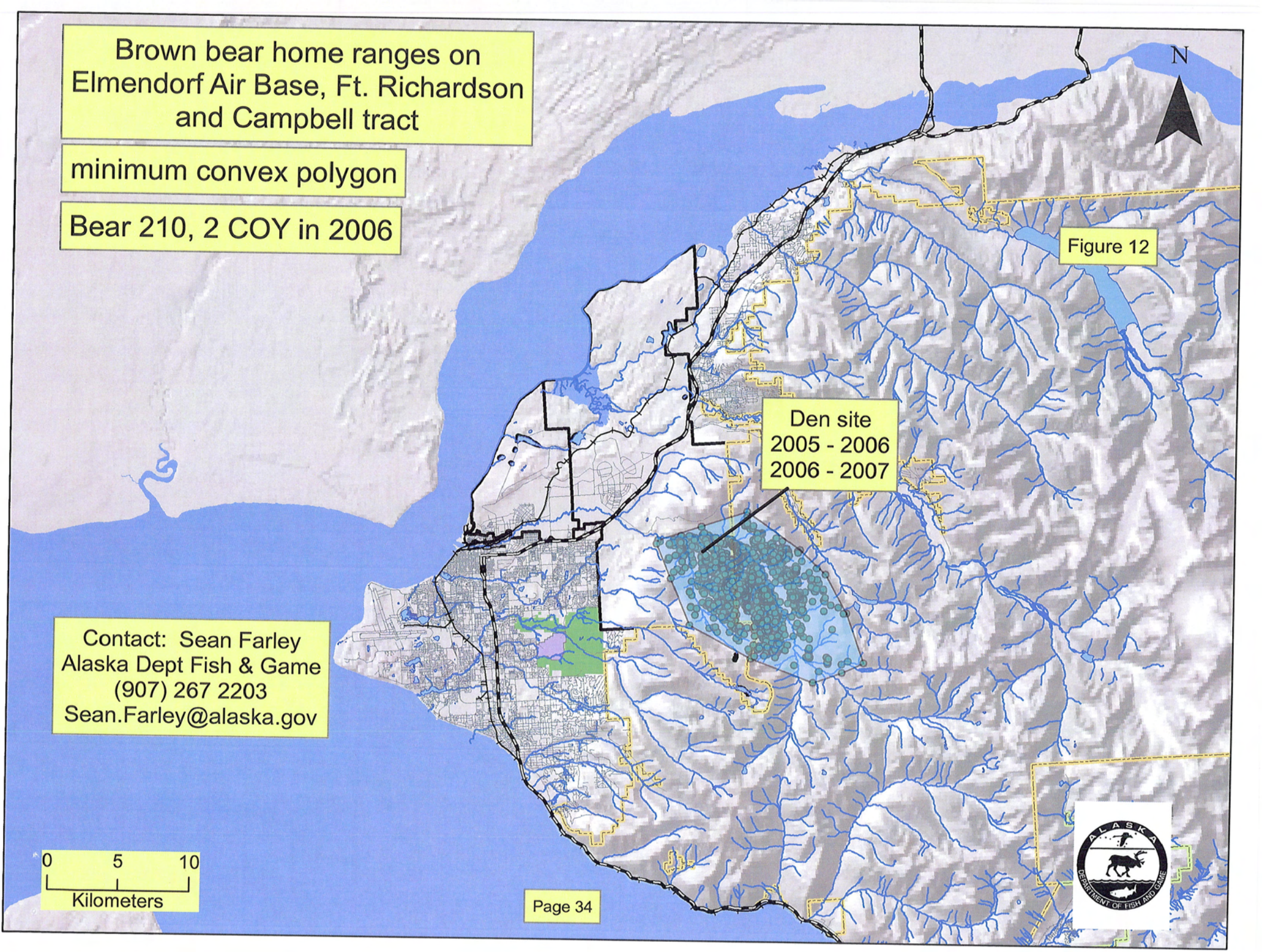
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell tract
minimum convex polygon
Bear 210, 2 COY in 2006
N
Figure 12
Den site
2005 - 2006
2006 - 2007
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Alaska Dept Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
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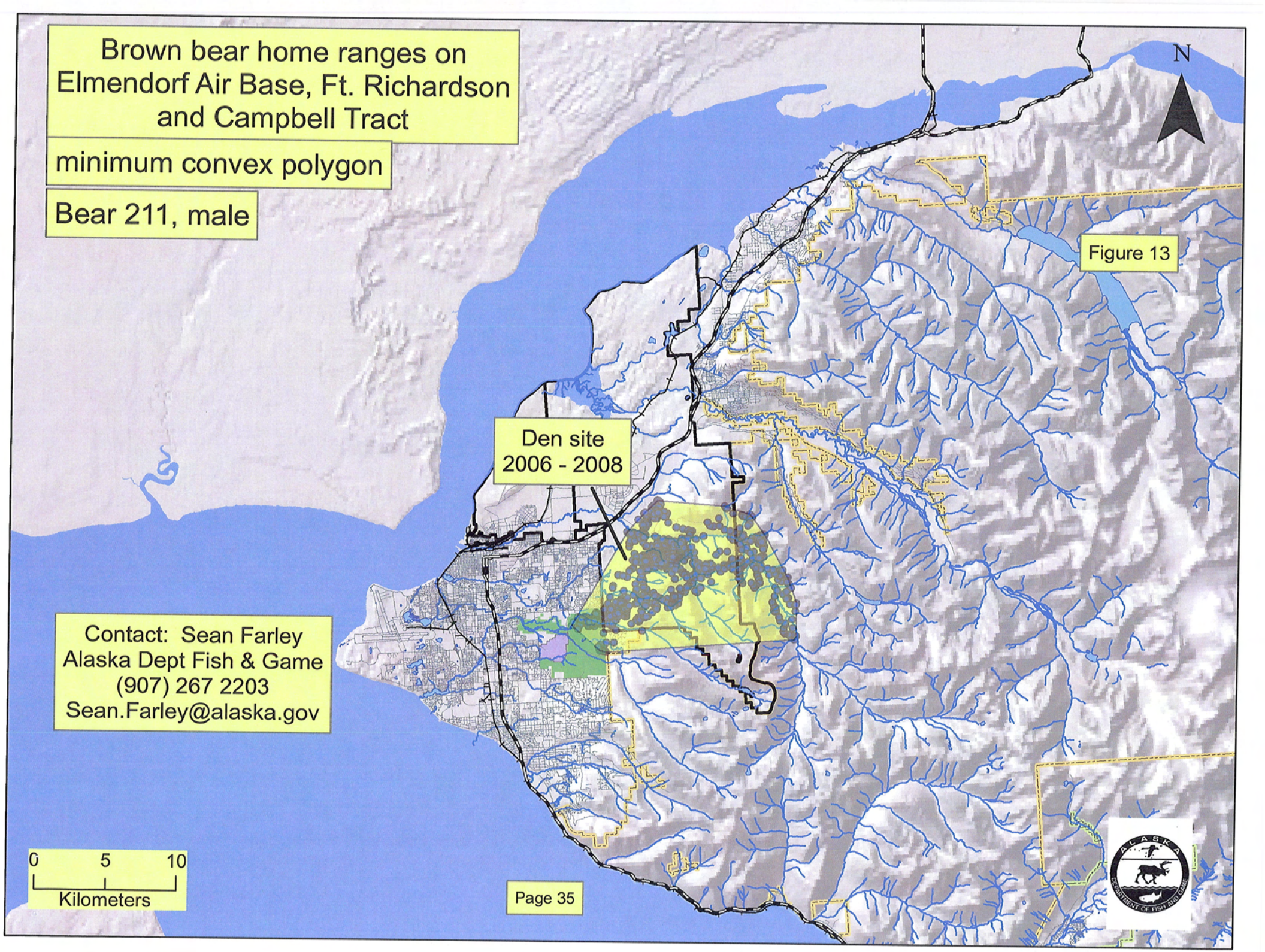
Brown bear home ranges on
Elmendorf Air Base, Ft. Richardson
and Campbell Tract
minimum convex polygon
Bear 211, male
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Figure 13
Den site
2006 - 2008
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(907) 267 2203
Sean.Farley@alaska.gov
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Kilometers
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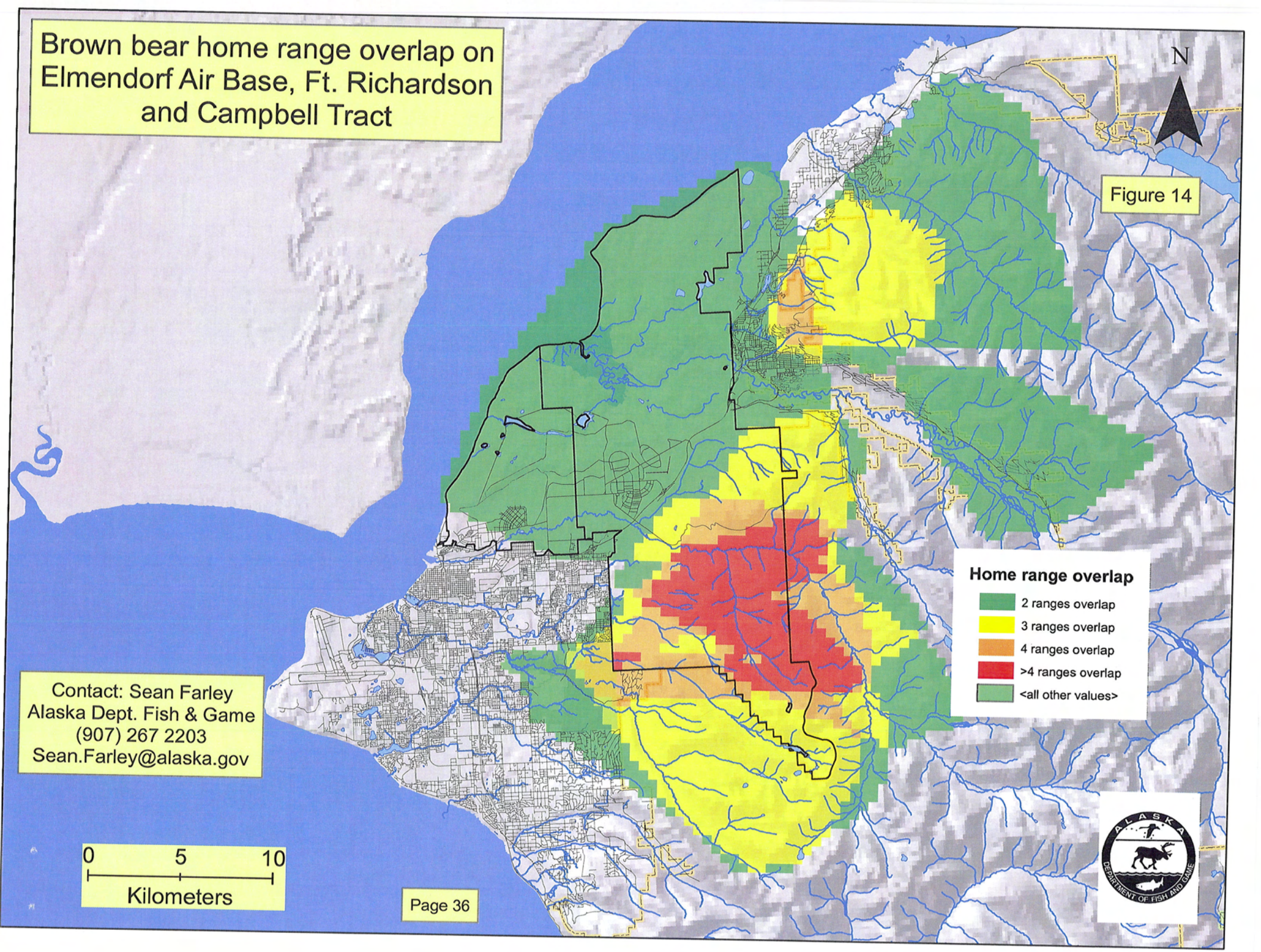
Brown bear home range overlap on Elmendorf Air Base, Ft. Richardson and Campbell Tract
N
Figure 14
Home range overlap
2 ranges overlap
3 ranges overlap
4 ranges overlap
>4 ranges overlap
<all other values>
Contact: Sean Farley
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Sean.Farley@alaska.gov
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Kilometers
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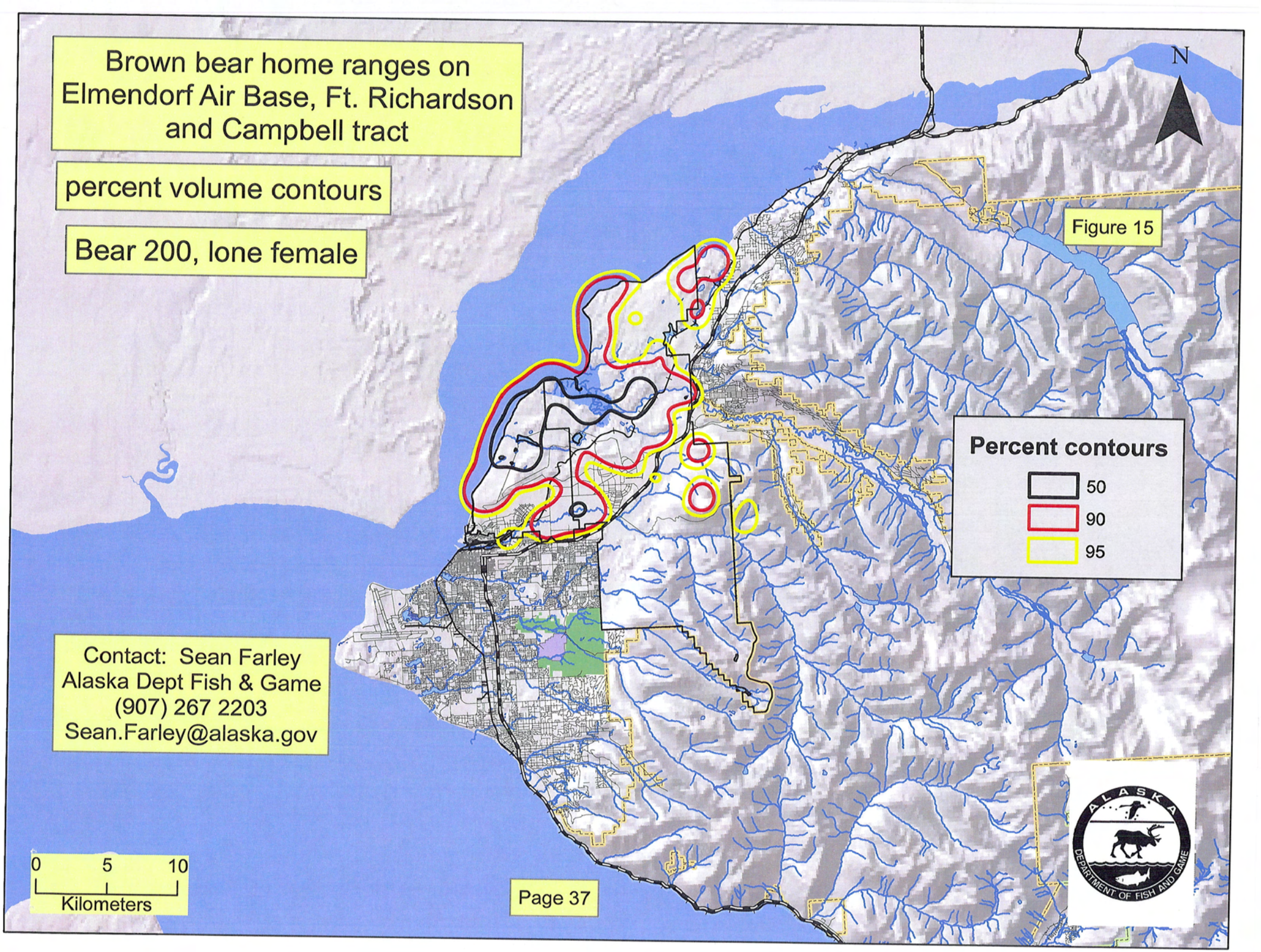
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell tract
percent volume contours
Bear 200, lone female
Figure 15
N
Percent contours
50
90
95
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ALASKA
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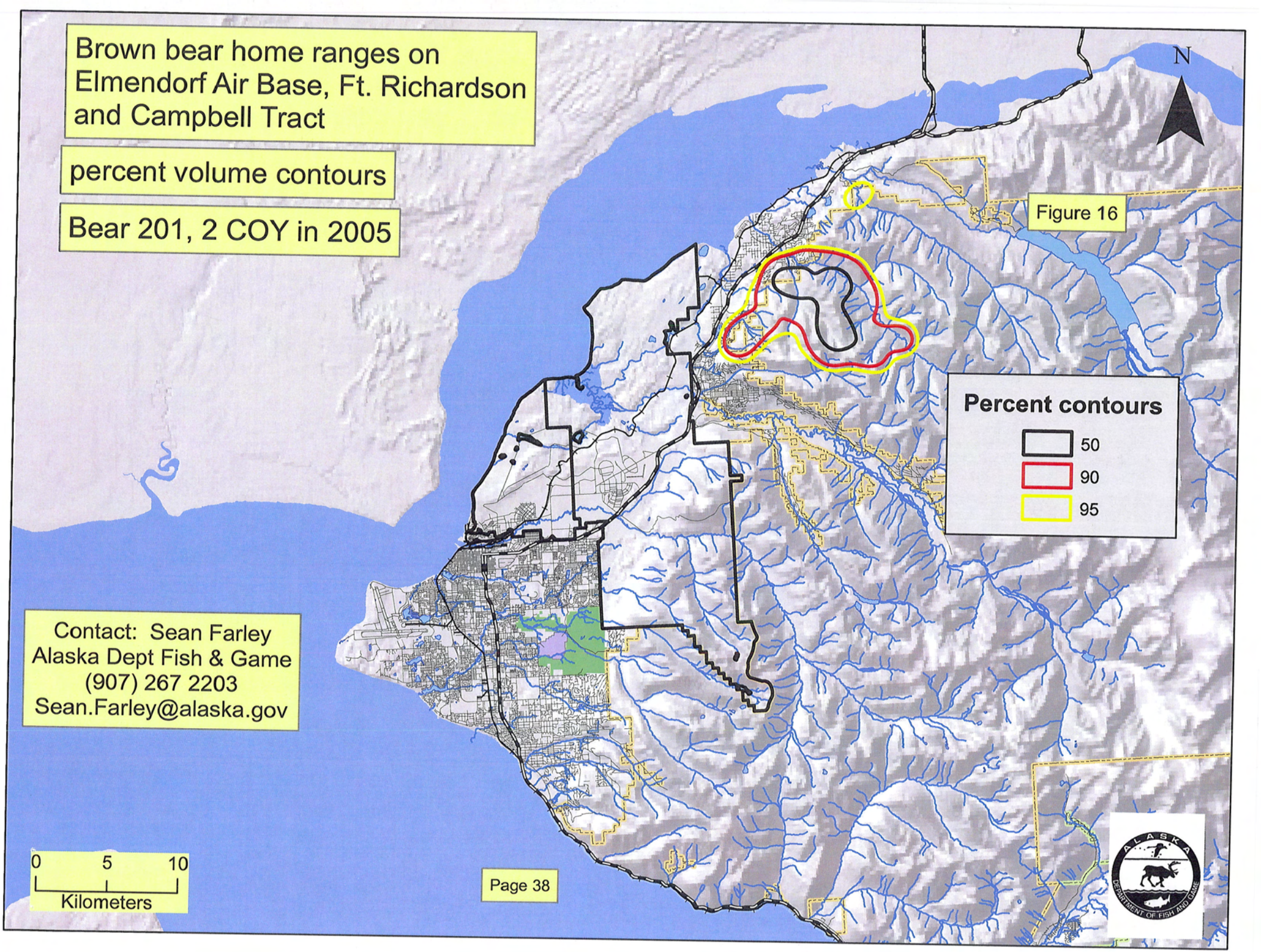
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 201, 2 COY in 2005
Figure 16
N
Percent contours
50
90
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ALASKA
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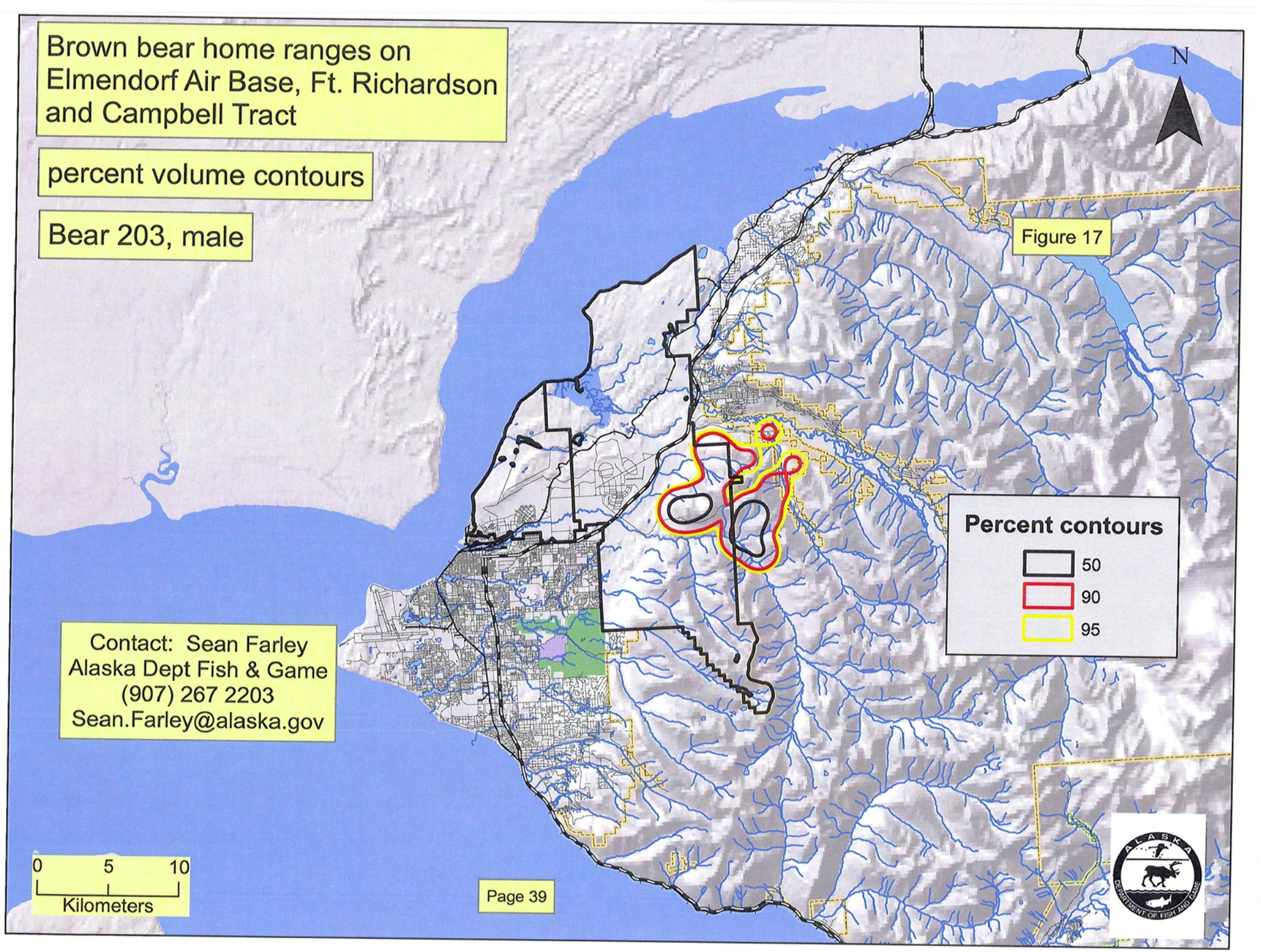
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 203, male
Figure 17
N
Percent contours
50
90
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Sean.Farley@alaska.gov
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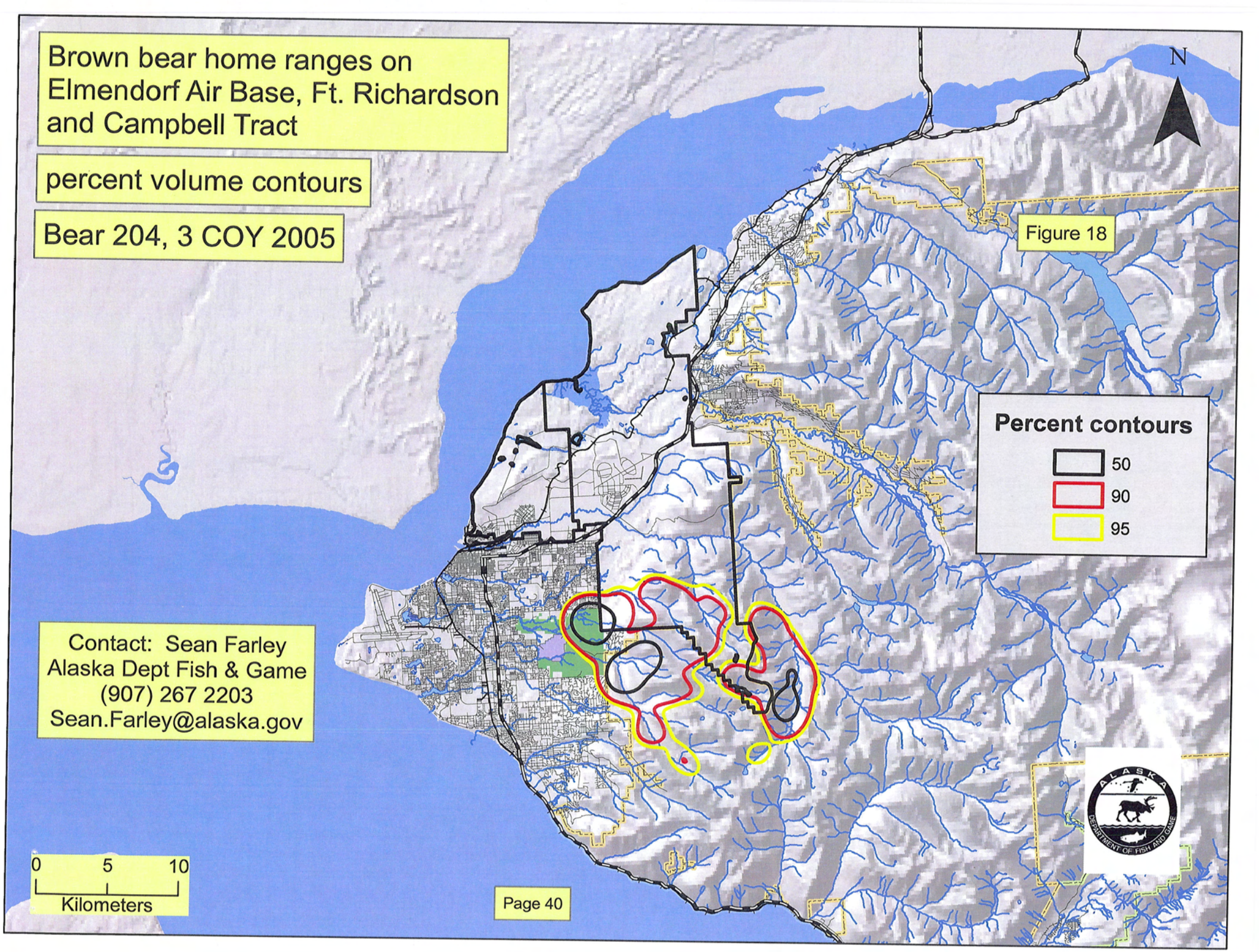
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 204, 3 COY 2005
Figure 18
N
Percent contours
50
90
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Contact: Sean Farley
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Sean.Farley@alaska.gov
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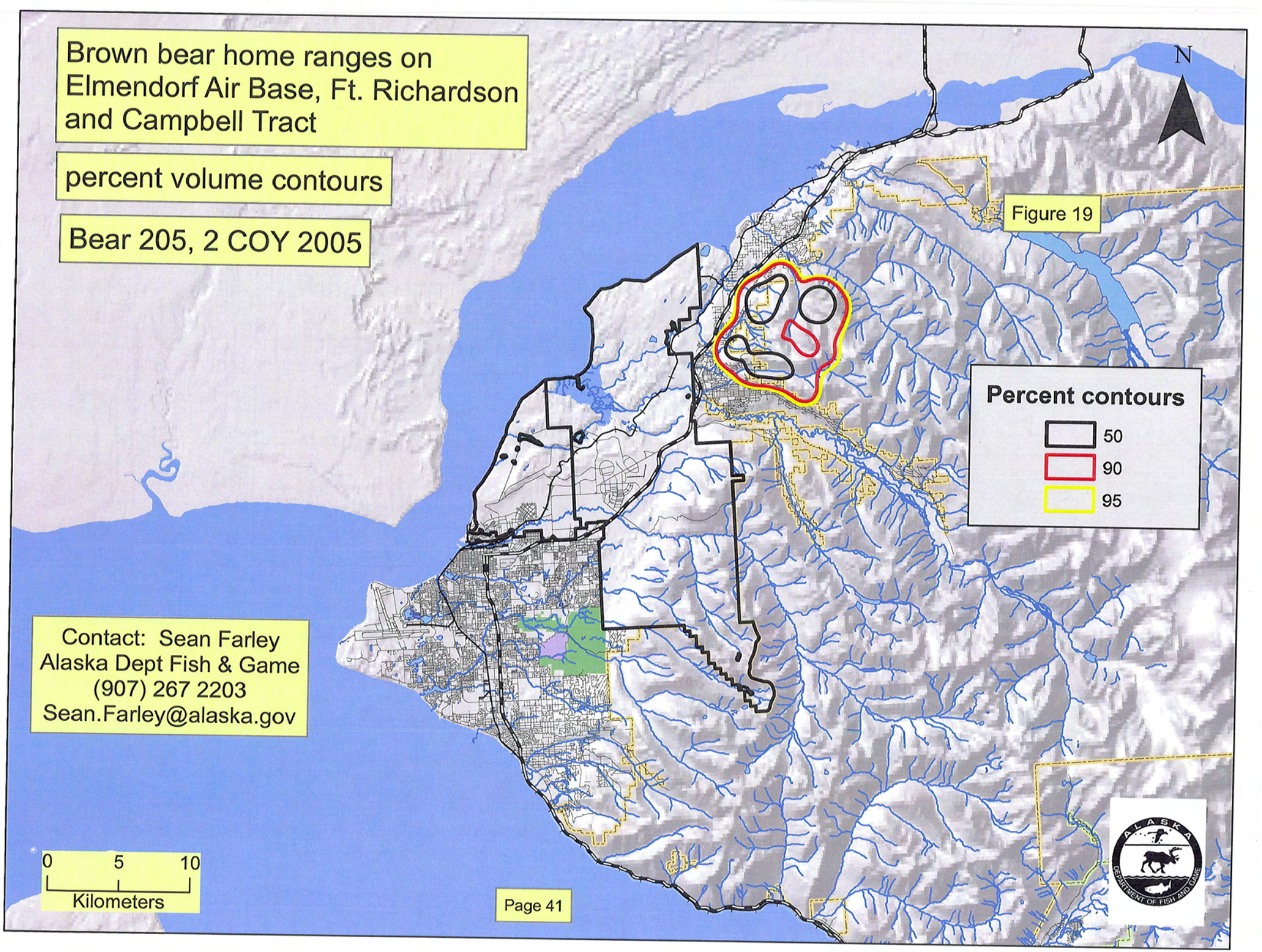
Brown bear home ranges on
Elmendorf Air Base, Ft. Richardson
and Campbell Tract
percent volume contours
Bear 205, 2 COY 2005
N
Figure 19
Percent contours
50
90
95
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Alaska Dept Fish & Game
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Sean.Farley@alaska.gov
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Kilometers
ALASKA
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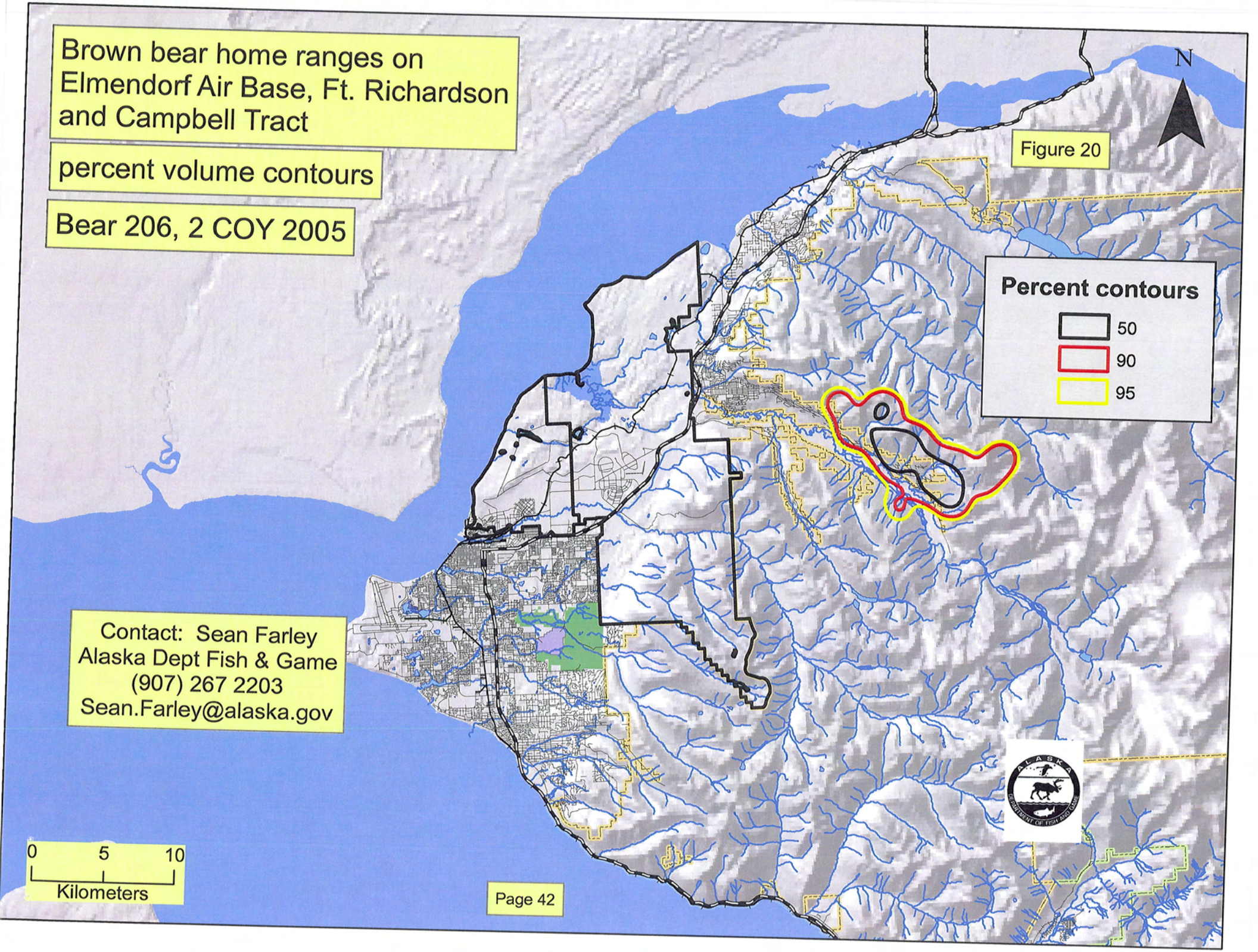
Page 41


Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 206, 2 COY 2005
Figure 20
N
Percent contours
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Sean.Farley@alaska.gov
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Kilometers
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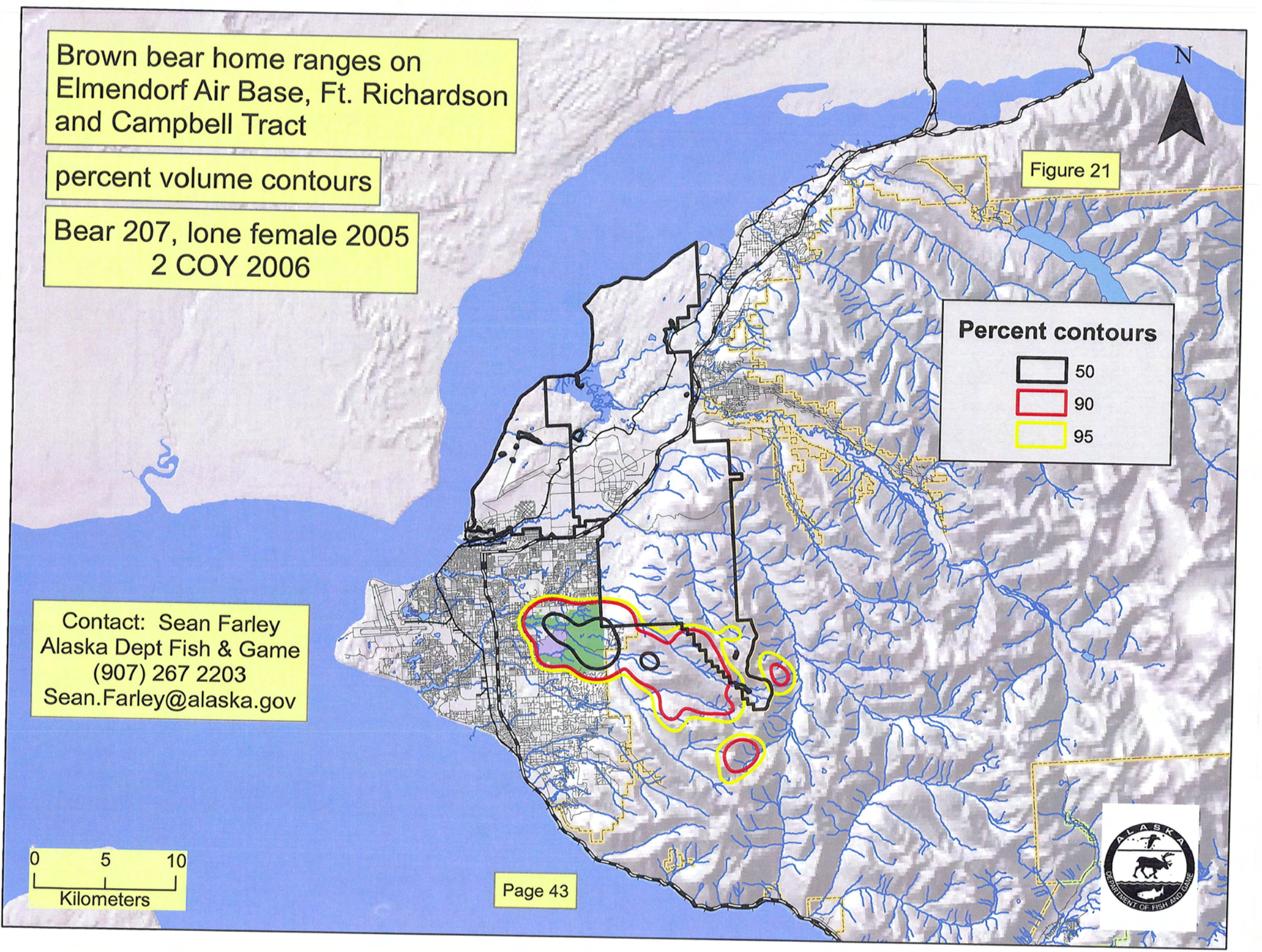
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 207, lone female 2005
2 COY 2006
N
Figure 21
Percent contours
50
90
95
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Sean.Farley@alaska.gov
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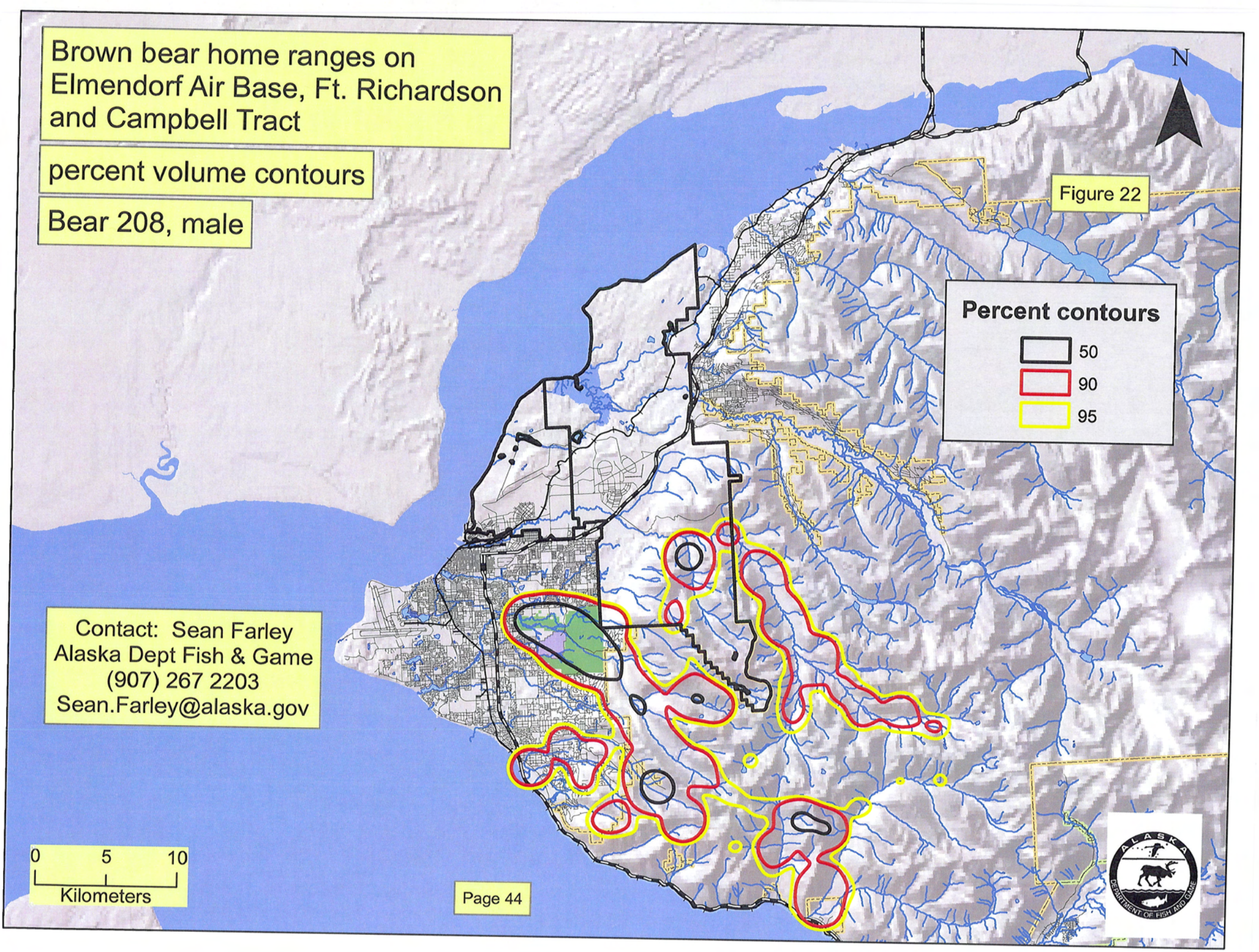
Brown bear home ranges on
Elmendorf Air Base, Ft. Richardson
and Campbell Tract
percent volume contours
Bear 208, male
Figure 22
N
Percent contours
50
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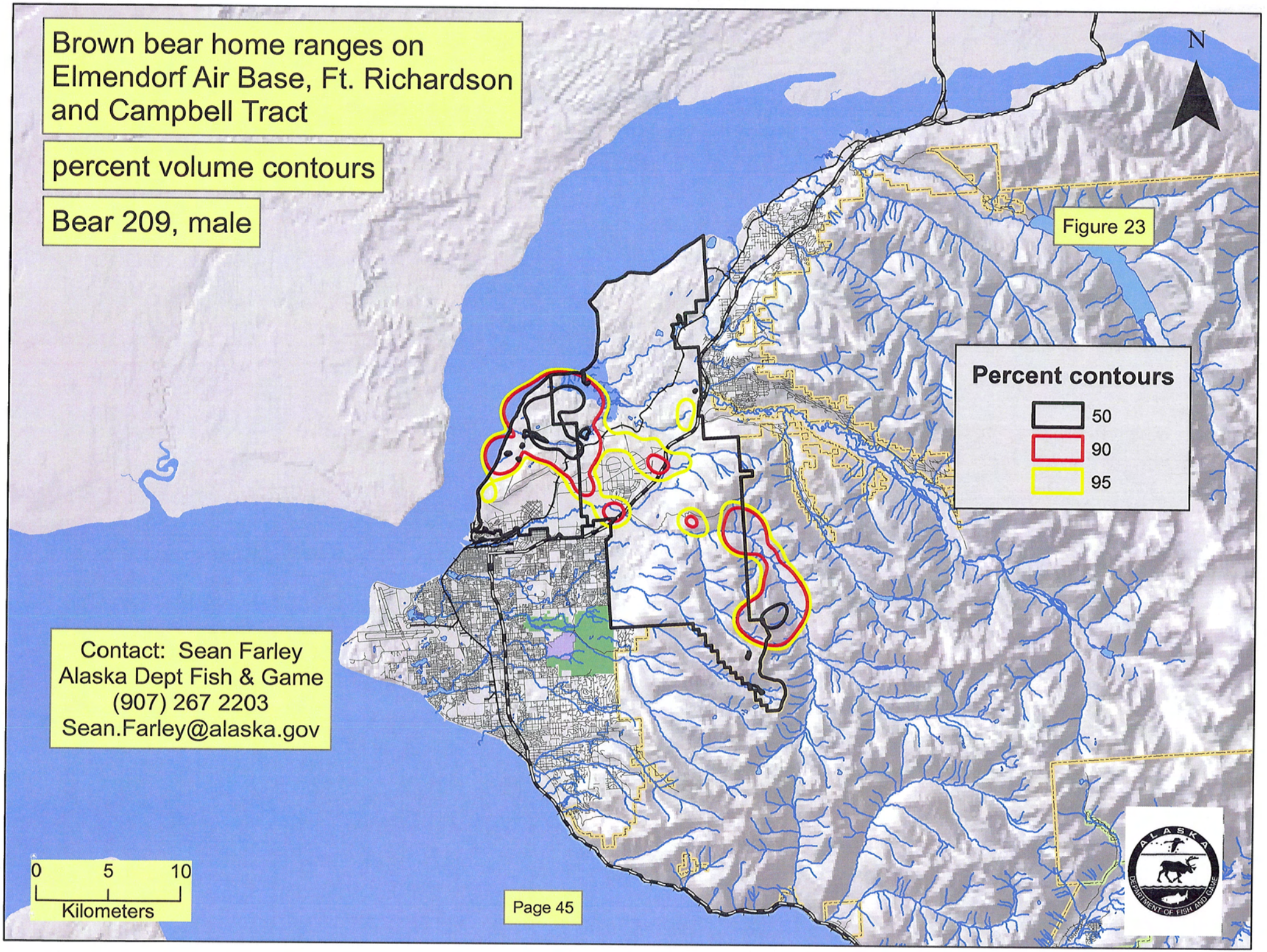
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 209, male
Figure 23
N
Percent contours
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Sean.Farley@alaska.gov
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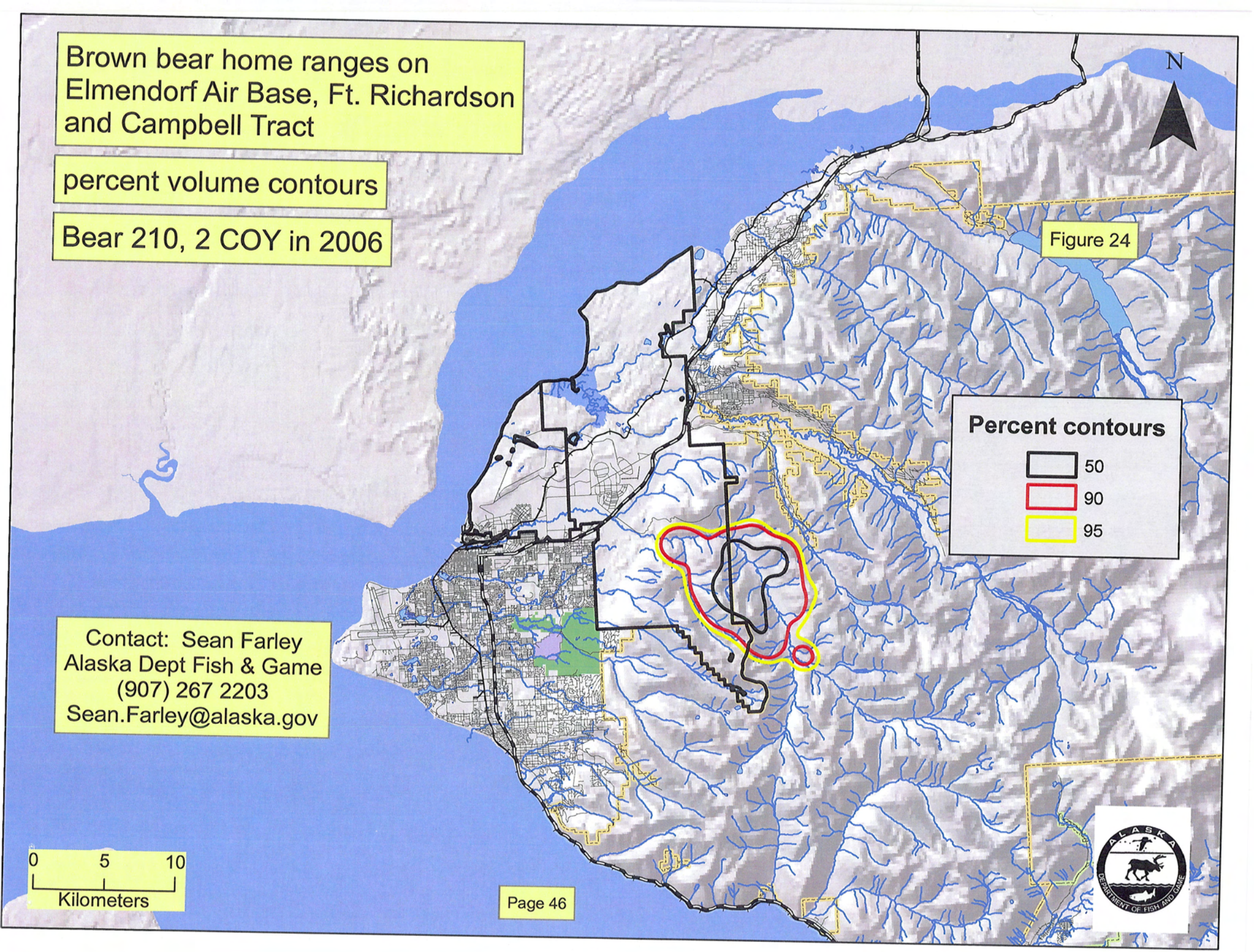
Kilometers
Page 45


Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 210, 2 COY in 2006
Figure 24
N
Percent contours
50
90
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Sean.Farley@alaska.gov
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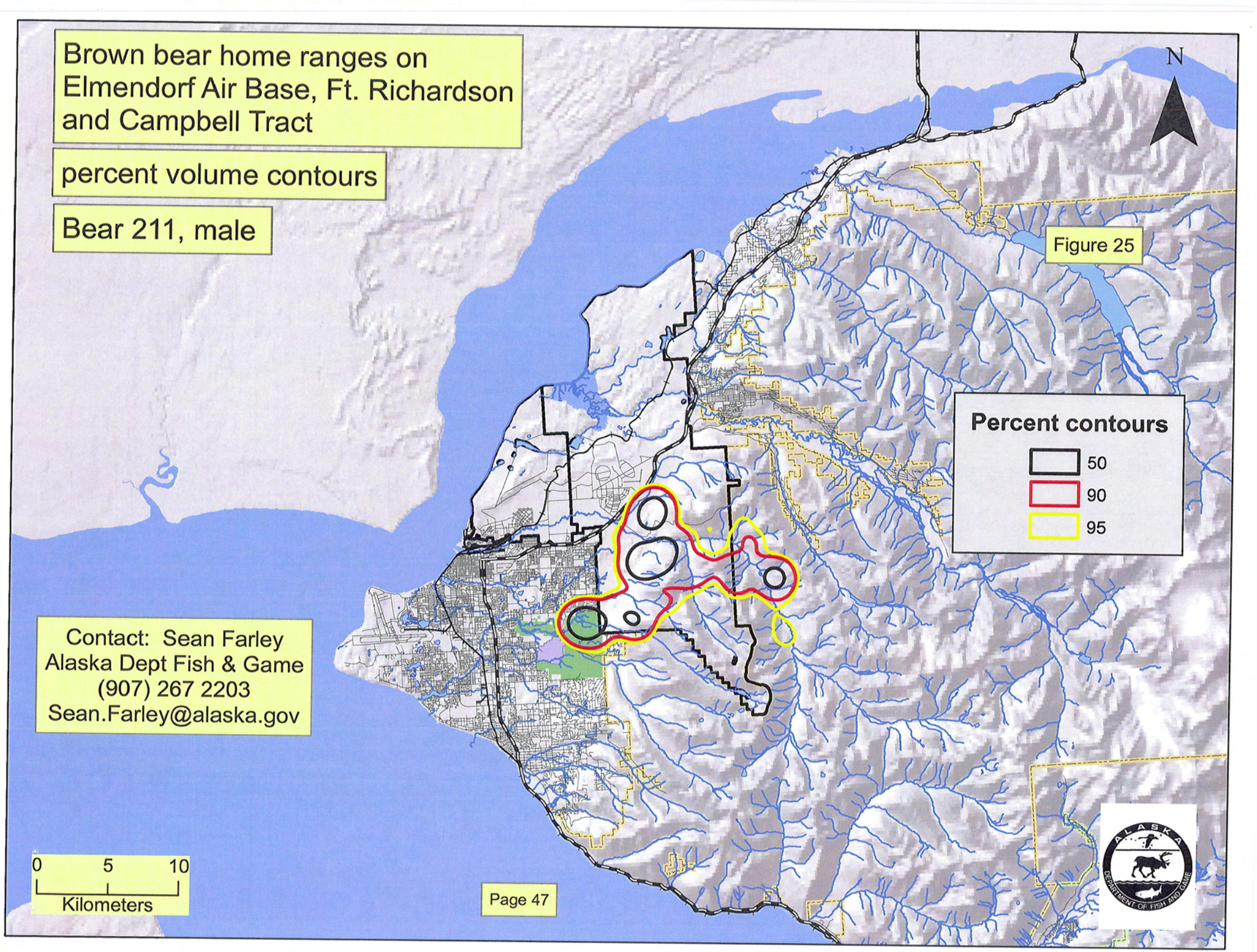
Brown bear home ranges on Elmendorf Air Base, Ft. Richardson and Campbell Tract
percent volume contours
Bear 211, male
N
Figure 25
Percent contours
50
90
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Sean.Farley@alaska.gov
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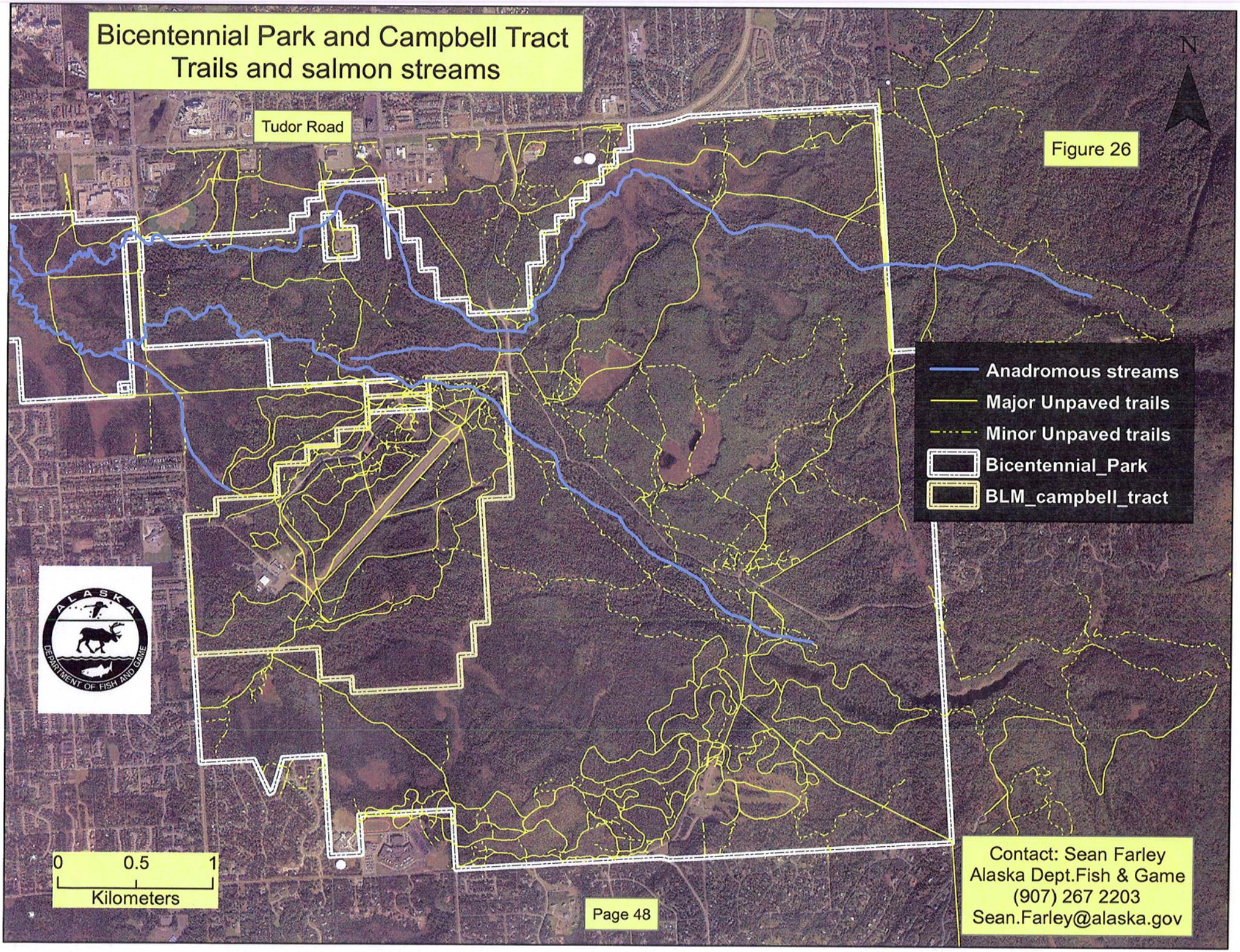
Bicentennial Park and Campbell Tract
Trails and salmon streams
Tudor Road
N
Figure 26
Anadromous streams
Major Unpaved trails
Minor Unpaved trails
Bicentennial_Park
BLM_campbell_tract
ALASKA
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Kilometers
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Alaska Dept.Fish & Game
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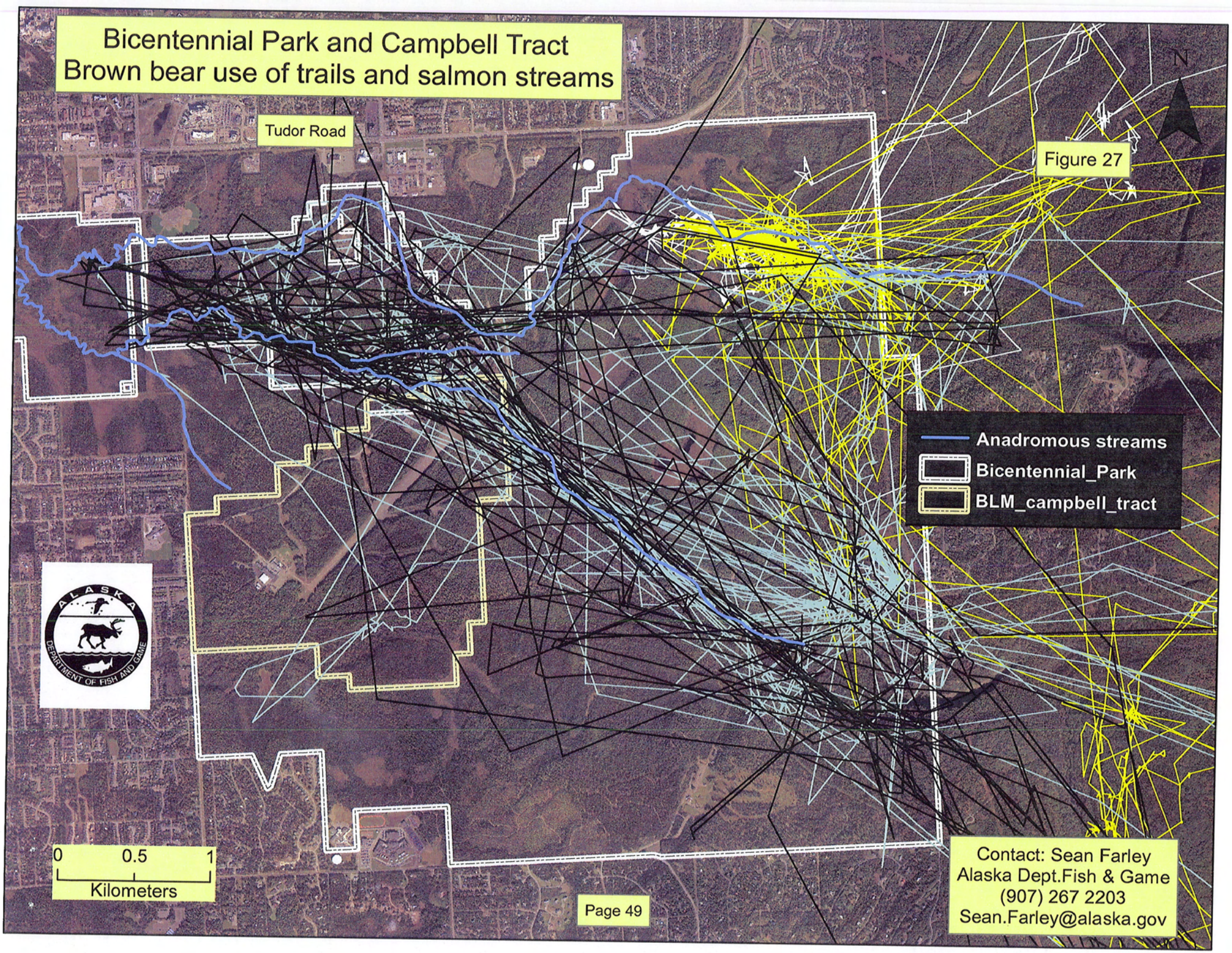
Sean.Farley@alaska.gov


Bicentennial Park and Campbell Tract
Brown bear use of trails and salmon streams
Tudor Road
Figure 27
N
Anadromous streams
Bicentennial_Park
BLM_campbell_tract
ALASKA
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Kilometers
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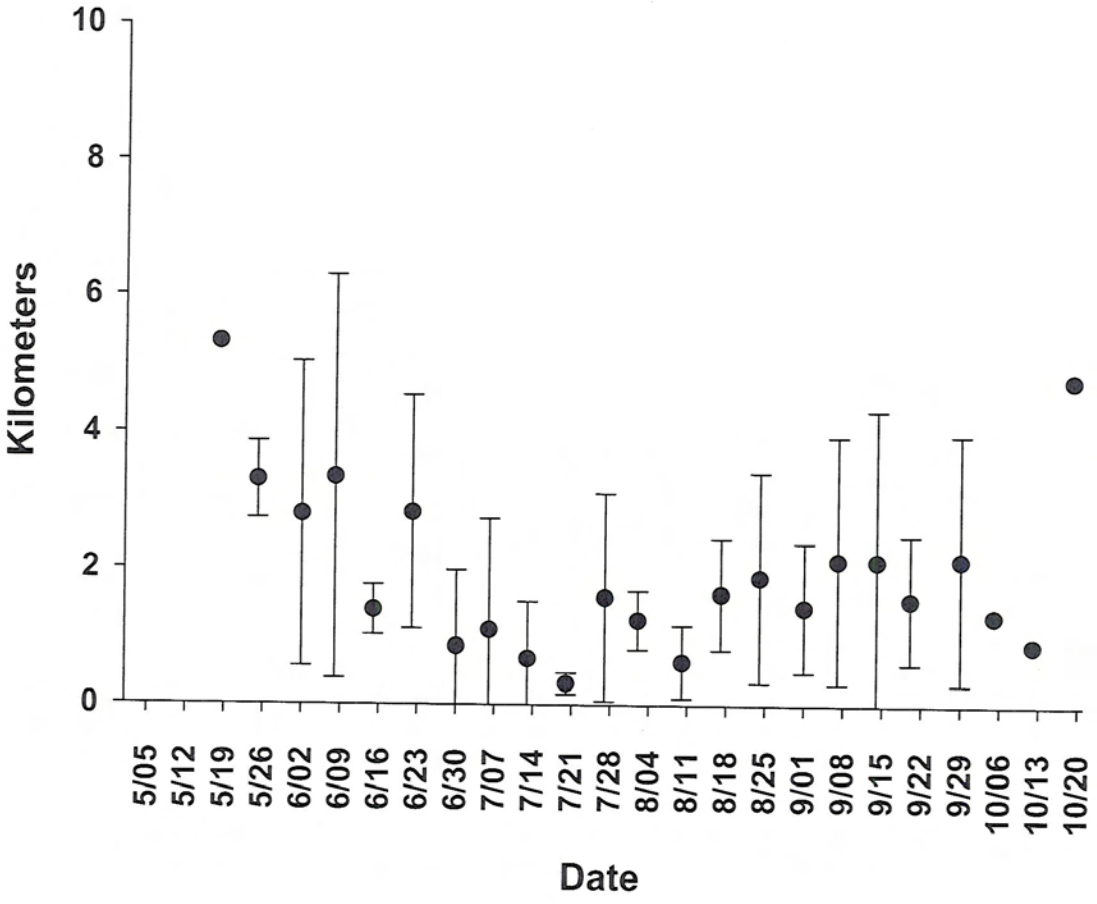
Alaska Dept.Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov

Distance to major unpaved trails

● Bears 204, 207, 208, 211

n = 8,127 locations

Figure 28

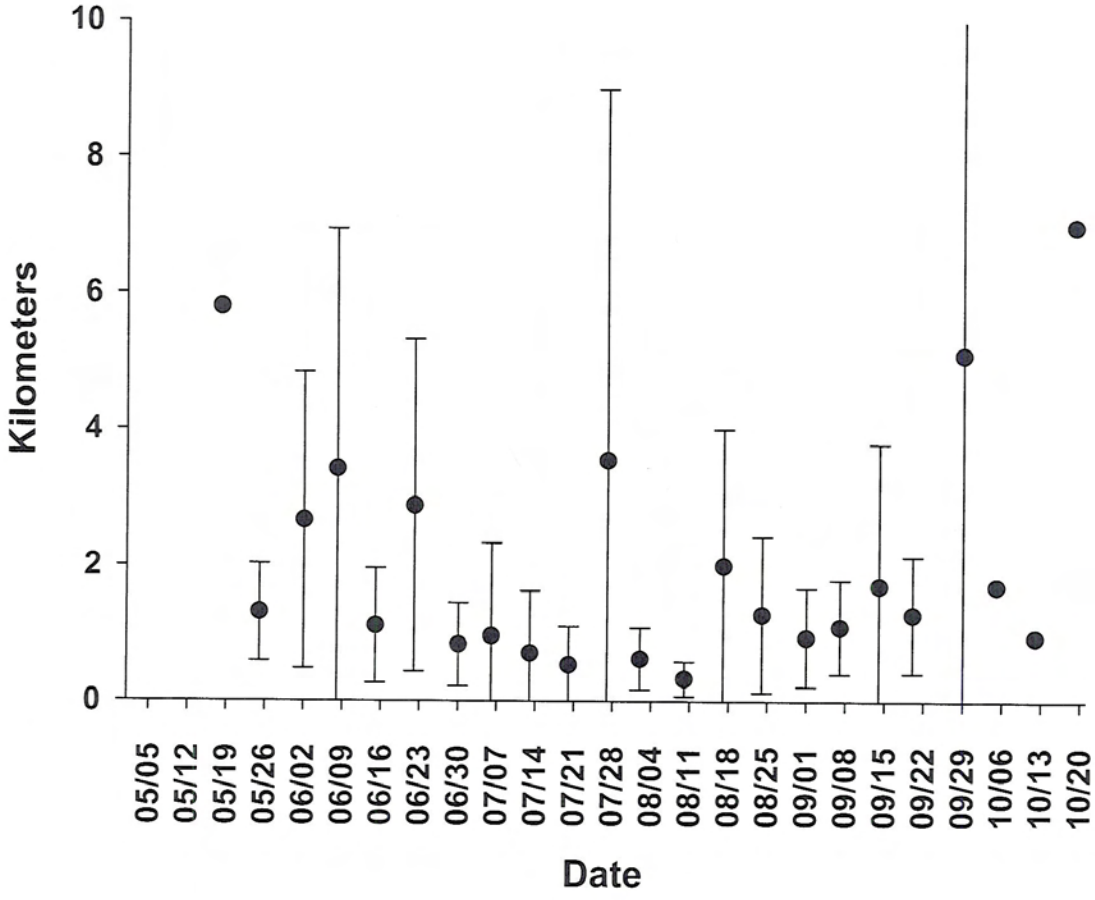


Distance to minor unpaved trails

● Bears 204, 207, 208, 211

n = 7,810 locations

Figure 29



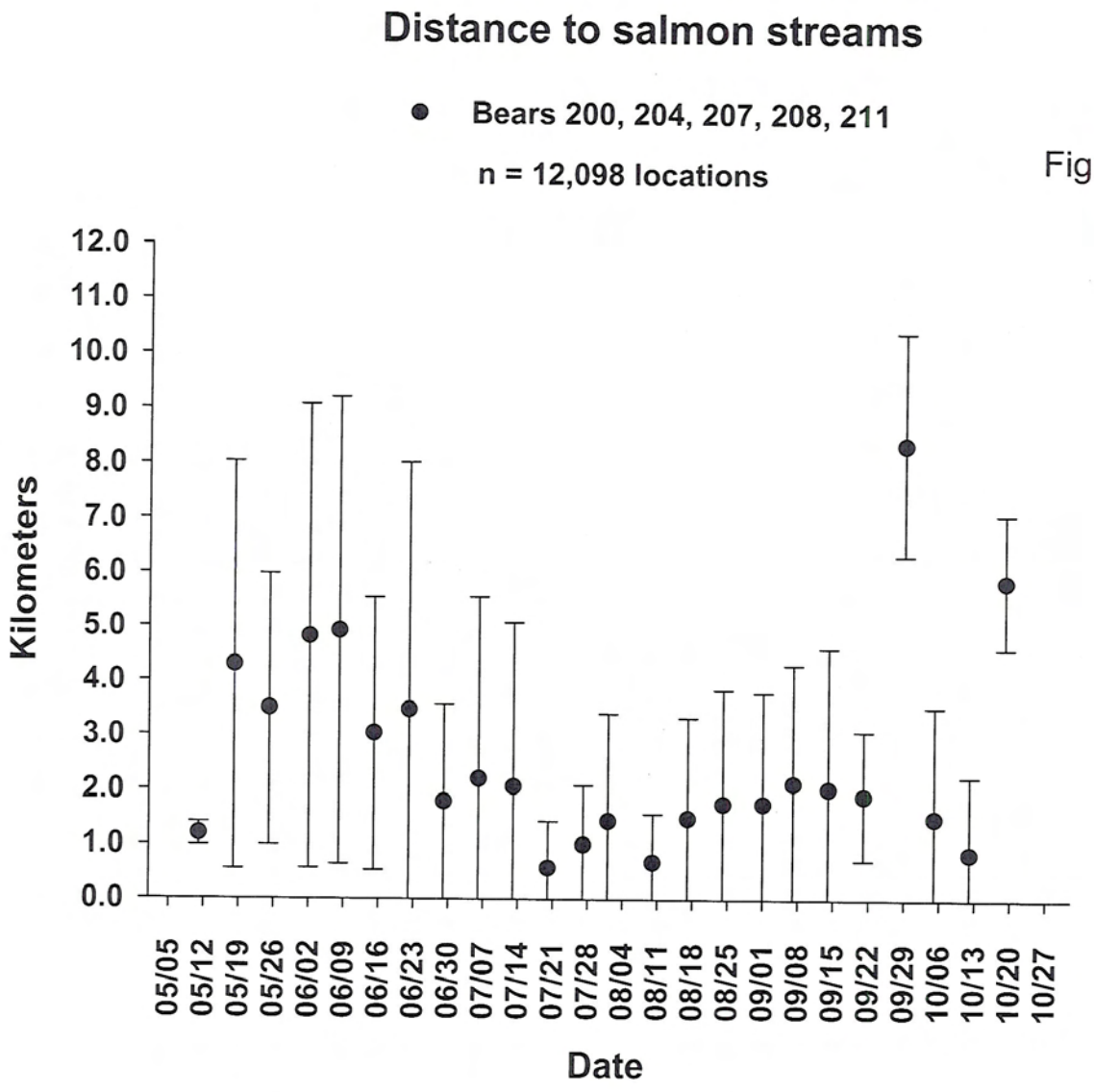

Distance to salmon streams
Bears 200, 204, 207, 208, 211
n = 12,098 locations
Kilometers
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
05/05
05/12
05/19
05/26
06/02
06/09
06/16
06/23
06/30
07/07
07/14
07/21
07/28
08/04
08/11
08/18
08/25
09/01
09/08
09/15
09/22
09/29
10/06
10/13
10/20
10/27
Date

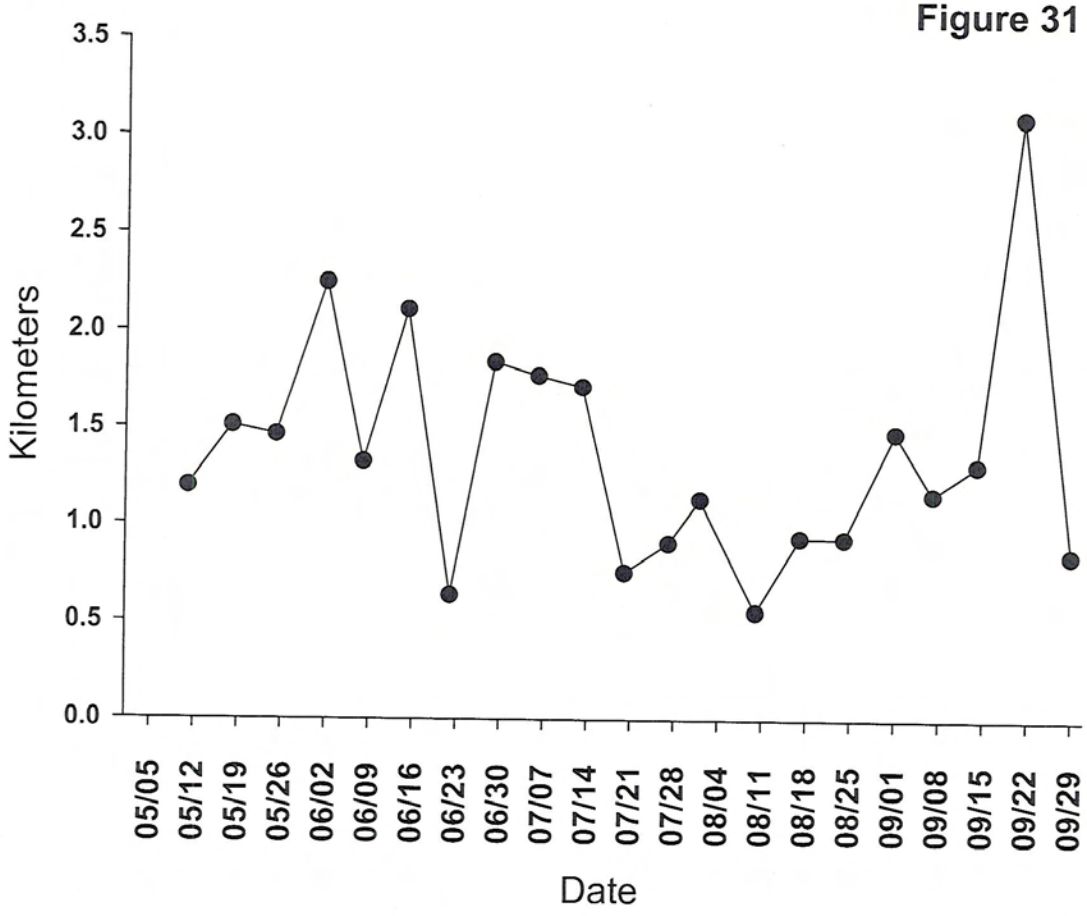
Figure 30

Distance to salmon streams

Bear 200 (lone female) n = 4,289 locations

(This bear spent considerable time on Ship Creek west of the Glenn Highway, and on Six Mile Creek on Elmendorf. She likely will have her first litter in 2008)

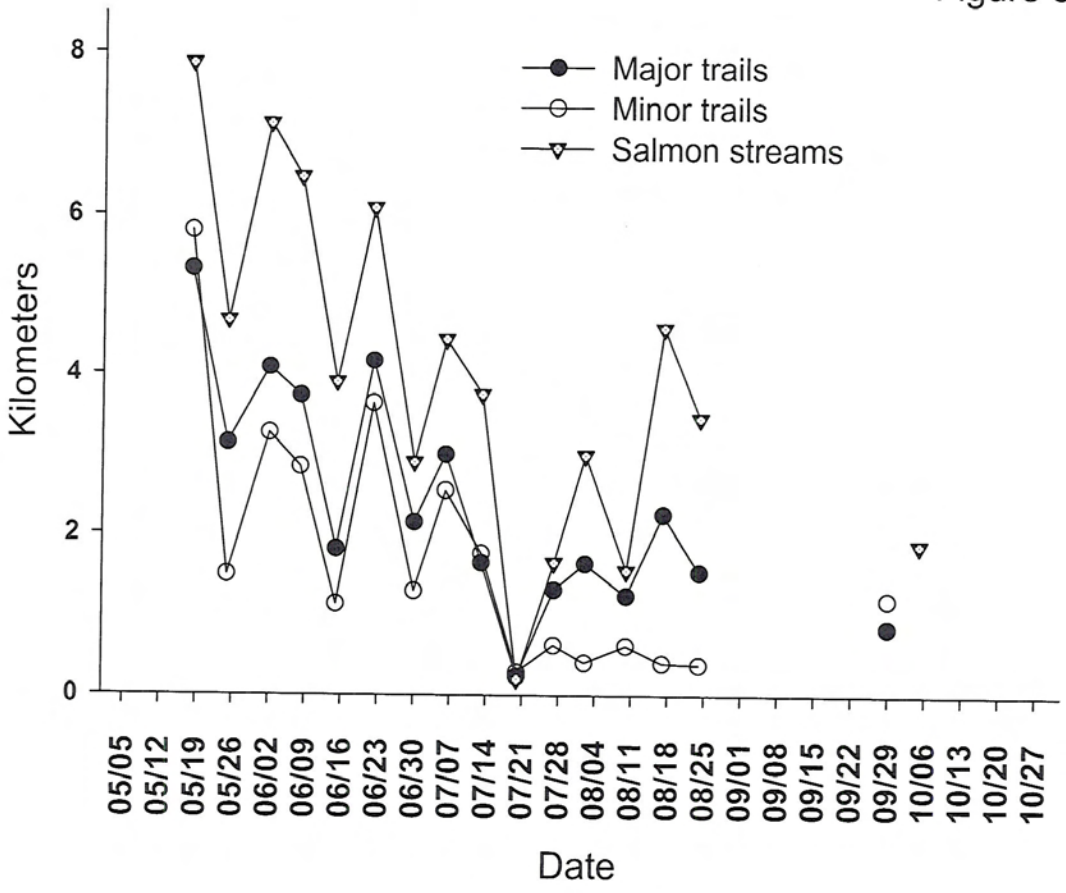
Figure 31



Mean distance from trails and salmon streams

Bear 204: female with young
(She successfully weaned 3 cubs and lived during the summers on the N Fk. Campbell Ck)
n = 1,978 locations

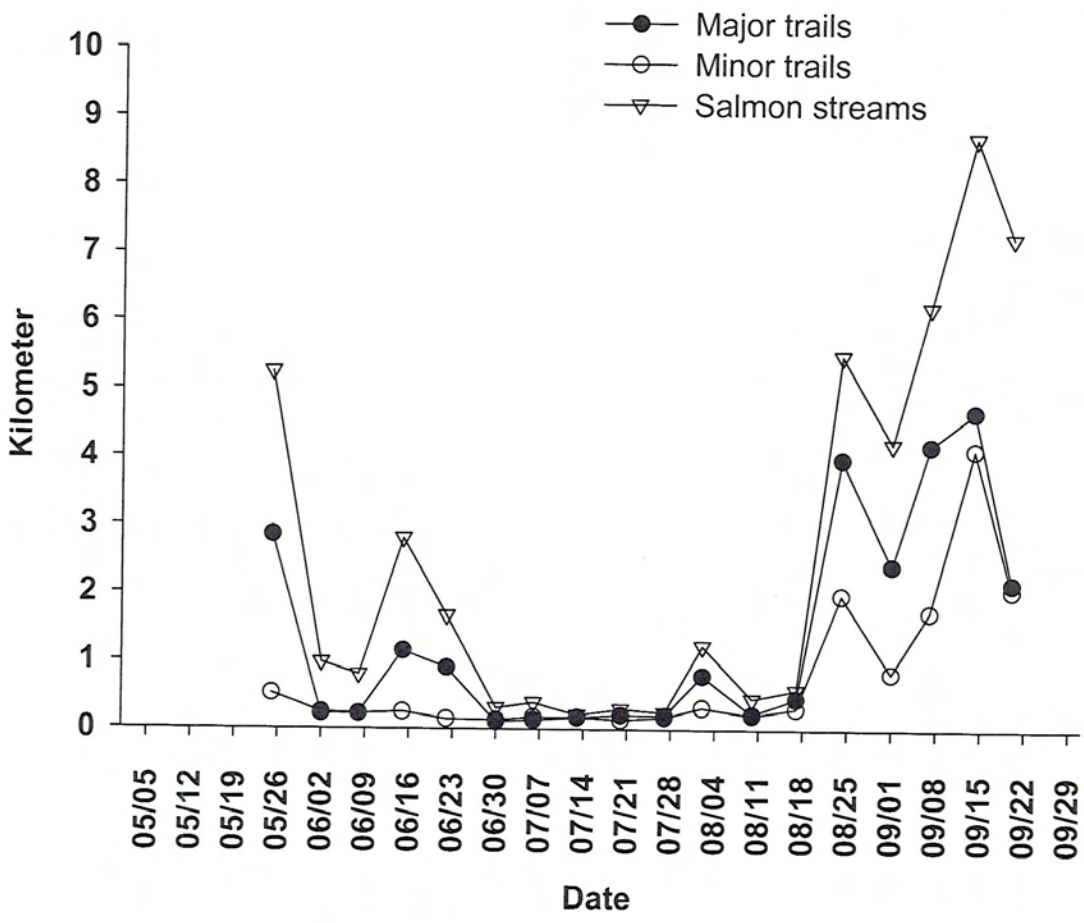
Figure 32



Mean distance from trails and salmon streams

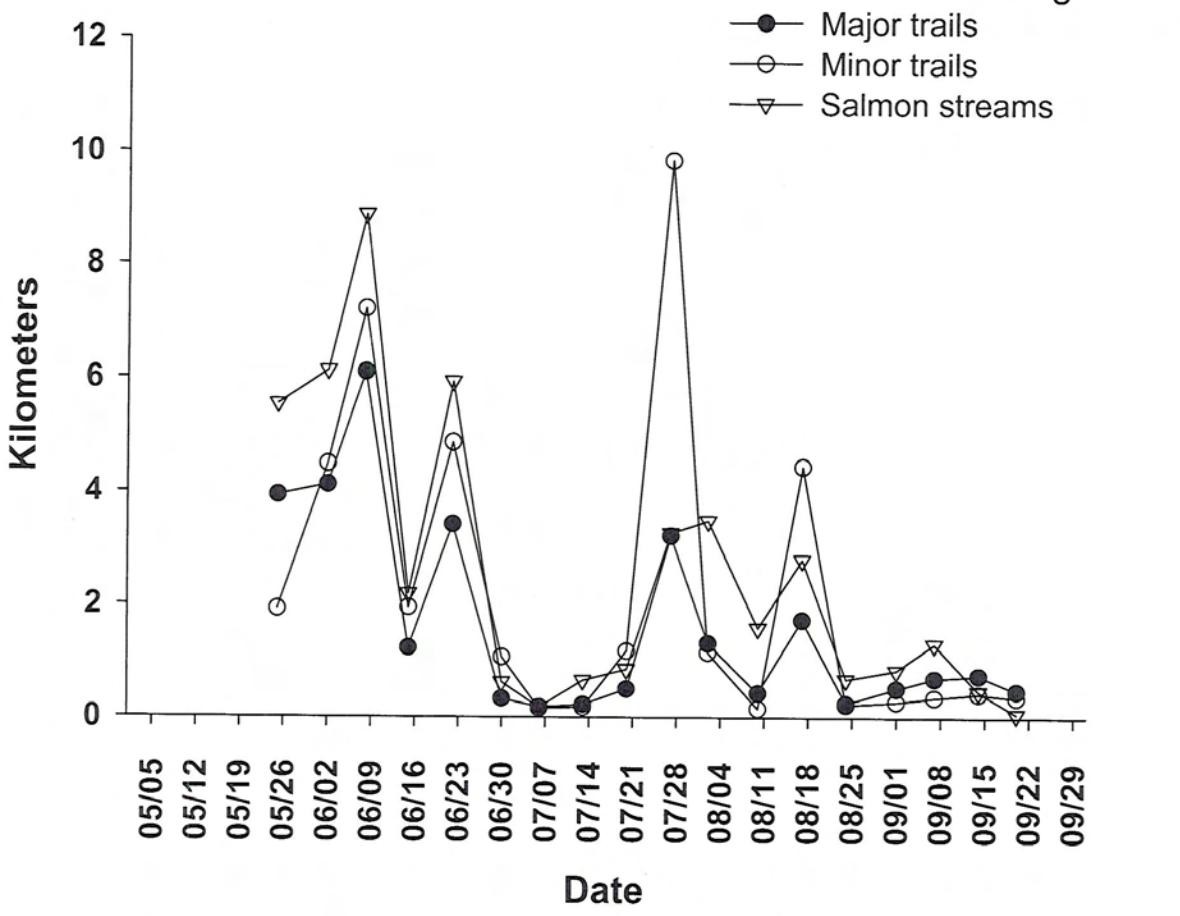
Bear 207: lone female; n=1,521 locations (She spent the summers on the N and S Fk of Campbell Creek; she produced and lost 2 COY in 2006)

Figure 33



Mean distance from trails and salmon streams
Bear 208: male; n = 1,052 locations

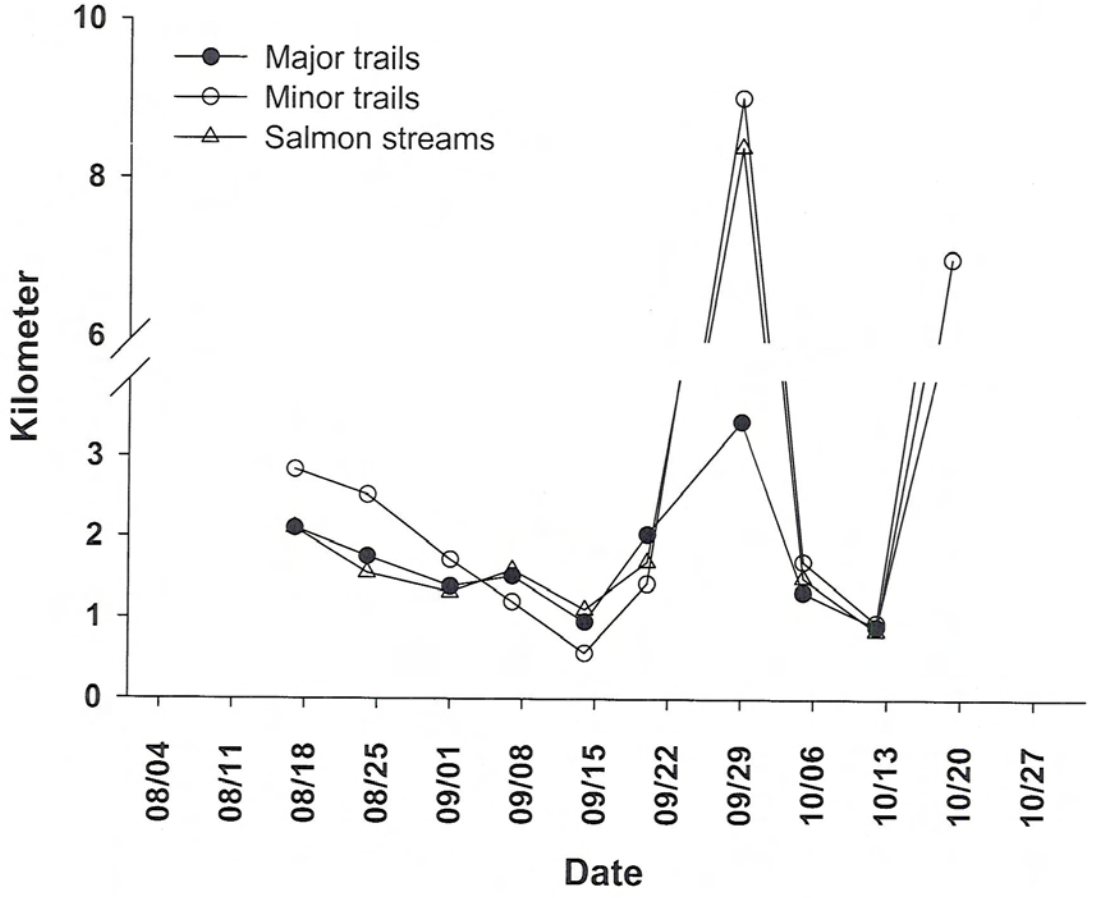
Figure 34

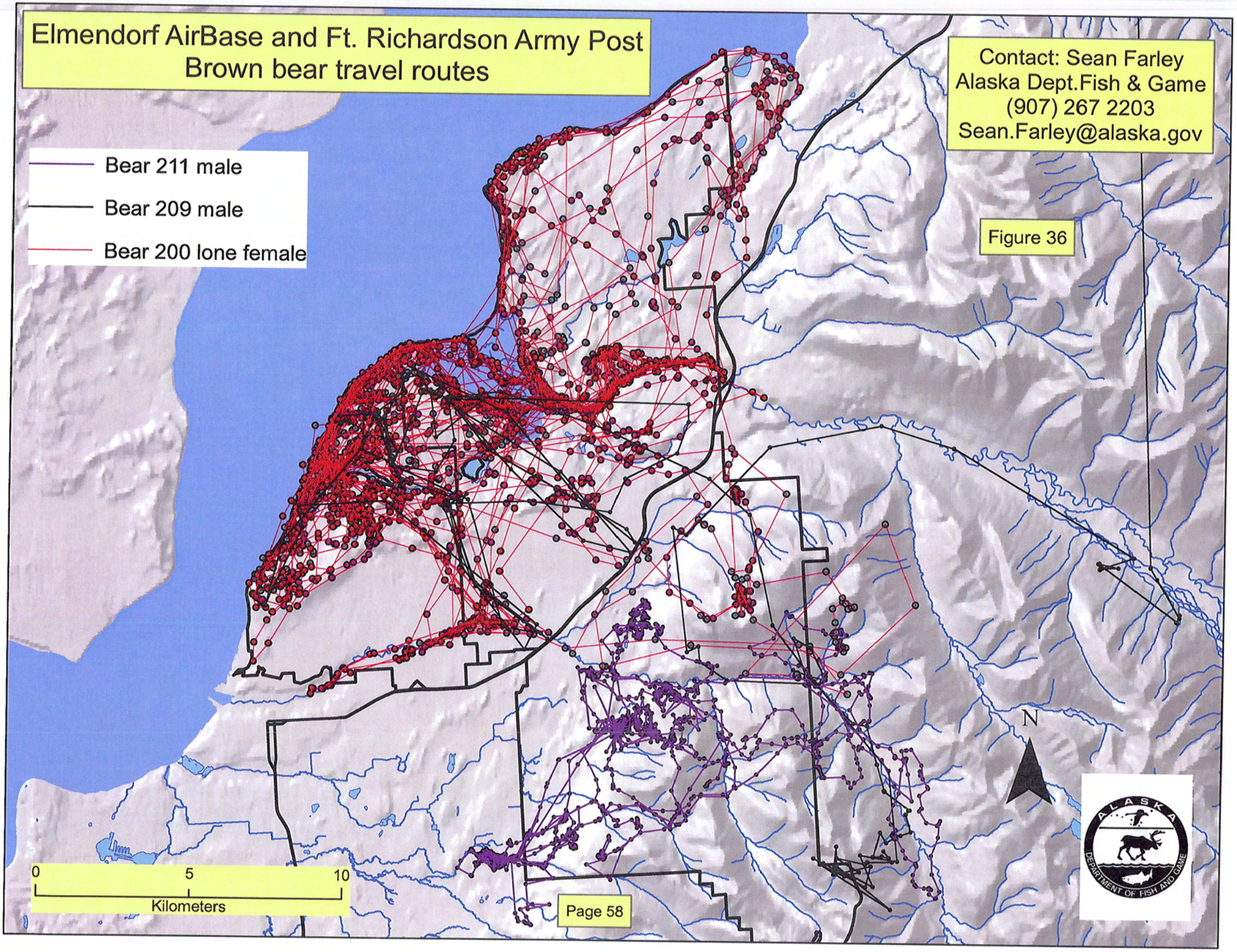


Distance from trails and salmon streams
Bear 211: male n = 3,259 locations

(This bear ranged from Moose Run Golf course to N. Fk. Campbell Ck behind Anchorage Police Department headquarters)

Figure 35




Elmendorf AirBase and Ft. Richardson Army Post
Brown bear travel routes
Contact: Sean Farley
Alaska Dept.Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
Bear 211 male
Bear 209 male
Bear 200 lone female
Figure 36
N
0
5
10
Kilometers
ALASKA
DEPARTMENT OF FISH AND GAME

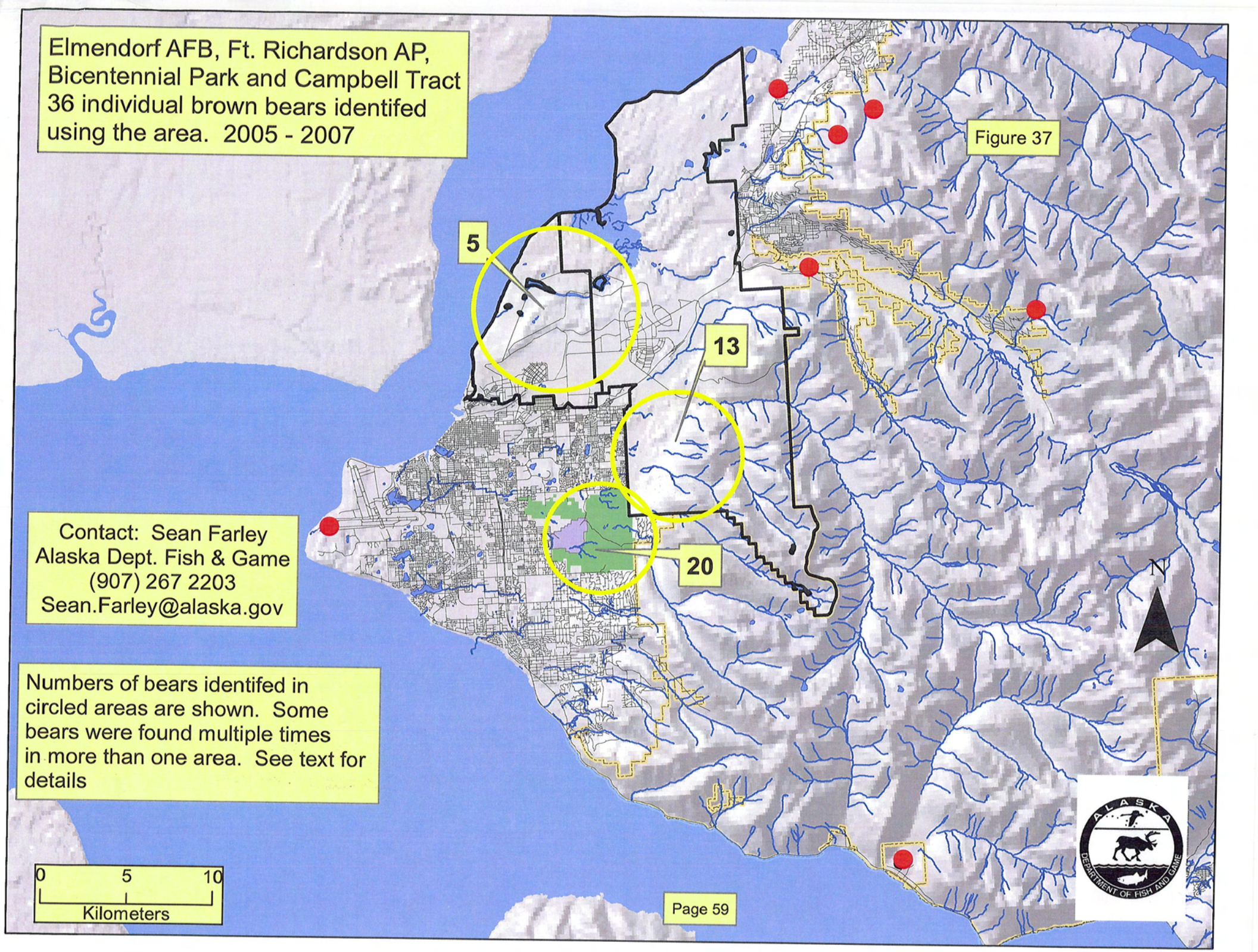

Elmendorf AFB, Ft. Richardson AP, Bicentennial Park and Campbell Tract 36 individual brown bears identifed using the area. 2005 - 2007
Figure 37
5
13
20
Contact: Sean Farley
Alaska Dept. Fish & Game
(907) 267 2203
Sean.Farley@alaska.gov
Numbers of bears identifed in circled areas are shown. Some bears were found multiple times in more than one area. See text for details
N
0 5 10
Kilometers
ALASKA DEPARTMENT OF FISH AND GAME
Page 59

FIgure 38

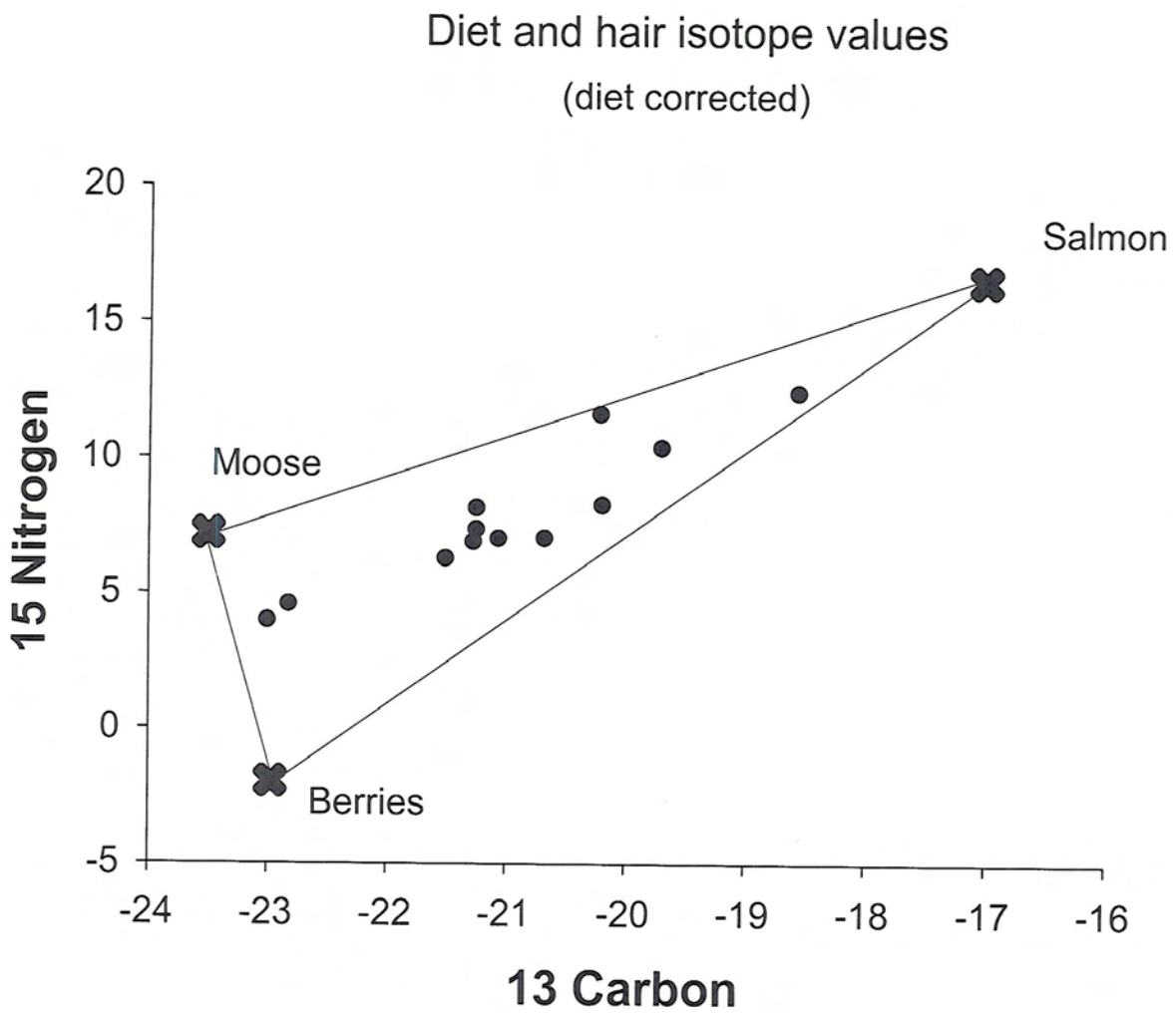

Diet and hair isotope values
(diet corrected)
20
15
10
5
0
-5
15 Nitrogen
Salmon
Moose
Berries
-24
-23
-22
-21
-20
-19
-18
-17
-16
13 Carbon

Table 1 Capture History

ID	Date	Sex	Age[a] (yrs)	Repro status	Body mass(kg)[b]	Capture method & location	Collar description, associated bears, comments (all collars GPS with spread spectrum technology and release mechanisms, release date noted
200	12-May-05	F	3	alone	144.1	barrel, Camp Mad Bull, Elmendorf	GPS-SST collar 11/06
200	21-Jun-06	F	4	estrus?	163.6	barrel, EOD creek, Elmendorf	GPS-SST collar, 11/06 estrus ?
200	17-Jul-07	F		alone	185.5	barrel, Eagle Glenn golf course, Elmendorf	GPS-SST collar, 12/07
201	24-May-05	F	10	lactating	160.9	helicopter, lower Peter's creek	GPS-SST collar, 11/06, 2 COY[c]
203	24-May-05	M	11	w/unk F	?	helicopter, Ship Ck	GPS-SST collar, 11/06, est wt. 450kg.
204	24-May-05	F	9	lactating	----	helicopter, N Fk Campbell Ck, near Tanaina lk.	GPS-SST collar, 11/06, 3 COY, no wt.
204	15-May-06	F	10	lactating	124.6	helicopter, Ship Ck, E. Temptation Pk.	GPS-SST collar, 11/06, 3 yearlings
205	25-May-05	F	7	lactating	155.7	helicopter, Meadow Ck valley	GPS-SST collar, 11/06, 2 COY
206	25-May-05	F	11	lactating	168.2	helicopter, Eagle R, E. Mt. Magnificent	GPS-SST collar, 11/06, 2 or 3 COY
207	26-May-05	F	3	w/208	113.9	helicopter, S. Fk. Campbell Ck, S. Wolverine Pk	GPS-SST collar, 11/06
208	26-May-05	M	4	w/207	205.9	helicopter, S. Fk. Campbell Ck, S. Wolverine Pk	GPS-SST collar, 11/06
209	25-Oct-05	M	3	alone	277.9	barrel, EOD Ck, Elmendorf	GPS-SST collar, 11/06, age suspect
210	15-May-06	F	6	lactating	111.9	helicopter, Ship Creek	GPS-SST collar, 11/06 2 COY
211	16-Aug-06	M	13	alone	291.5	barrel, Moose run Golf course Ft. Richardson	GPS-SST collar, 12/07
211	13-April 08	M	15	alone	291.5	helicopter, East of Muldoon road at 2500'	Collar removed, automatic release had failed

[a] Teeth aged by Matson's laboratory
[b] Electronic load cell
[c] COY = Cub of Year

Table 2 Collar history

ID	Collar started	Collar ended	Location days	Total locations	Poor locations	Acceptable locations	Collar fate
200	5/12/05	7/10/05	59	779	33	746	slipped collar
200	6/21/06	9/7/06	78	2170	94	2076	slipped collar
200	7/17/07	9/18/07	63	1930	189	1741	on air
201	5/24/05	11/10/05	170	4167	177	3990	GPS failed at 2006 den emergence, dropped as scheduled
203	5/24/05	5/28/05	4	50	0	50	slipped collar
204	5/24/05	8/21/05	89	901	18	883	GPS failed August 05
204	5/15/06	10/24/06	162	1142	31	1111	New GPS collar placed on animal, dropped as scheduled
205	5/25/05	6/25/06	396	1631	56	1575	GPS worked briefly after den emergence in 2006, then failed. Dropped as scheduled
206	5/25/05	7/27/05	63	909	28	881	slipped collar
207	5/26/05	9/26/05	123	1612	74	1538	GPS failed September 05
208	5/26/05	9/20/05	117	1175	51	1124	GPS failed September 05
209	10/25/05	5/26/06	213	458	10	448	GPS worked briefly after 2006 den emergence, failed May 06. Shot by hunter
210	5/21/06	11/27/06	190	2542	77	2465	GPS worked, collar dropped as scheduled
211	8/16/06	10/18/06	63	3440	198	3242	GPS failed October 06, failed to release when programmed, collar recovered by recapture spring 2008

Table 3 Home range comparisons

	Home Range (km^2)			
	Percent Volume contour			Minimum convex polygon
Bear	95%	90%	50%	Area
201 [a]	83	64	18	156
204 [a]	135	104	21	173
205 [a]	68	57	19	58
206 [a]	68	56	18	72
210 [a]	79	63	21	106
Mean	87	69	19	113
Std	28	20	2	51
n	5			
200 [b]	193	141	31	329
207 [b]	101	74	14	132
Mean	147	108	23	231
n	2			
208 [c]	307	223	35	591
209 [c]	109	74	15	1703
211 [c]	94	73	18	125
Mean	170	123	23	806
Std	119	86	11	811
n	3			
203 [c]	60	47	12	42

[a] lactating
[b] lone female
[c] male (203 excluded for lack of data)

Table 4 Bears identified from DNA

Bear ID	Date	Sex	location
1	7/24/2006	MALE	S Fk Campbell creek, red bridge
2	8/3/2006	FEMALE	Riverview, Eagle river
3	8/8/2005	MALE	N. Fk Campbell Ck
4	7/15/2005	FEMALE	100 m upstream utilidor power line
5	5/31/2006	FEMALE	brown bear hair at moose kill in Bear Valley C. Marino-Anchorage
6	10/30/2006	MALE	Snowhawk cabin trail
7	7/4/2007	MALE	Anchorage Mtn View DLP by APD
8	8/8/2007	MALE	South Fk Campbell (?), 415
9	8/22/2007	MALE	Campbell S Fk 41A
10	8/22/2007	MALE	Campbell S Fk 41A
11	8/22/2007	MALE	Campbell S Fk 41A
12	8/31/2007	MALE	h7-152
13	8/29/2007	MALE	Gas line 08
13	8/30/2007	MALE	N Fk Campbell 58; 3 ft up tree
14	8/31/2007	FEMALE	Bird creek
15	8/9/2007	MALE	6 mile Ck EAFB, WP24A
16	7/20/2007	FEMALE	Birch Tree Drive, Chugiak, eating spoiled meat outdoor freezer.
17	5/4/2007	FEMALE	Snowhawk cabin trail
18	6/12/2007	MALE	N. Fk Campbell Ck
19	6/29/2007	MALE	Moose run Golf course
20	7/27/2007	FEMALE	N. Fk Campbell Ck
21	8/6/2007	MALE	Moose run Golf course
22	6/8/2007	FEMALE	Moose run Golf course
23	8/23/2007	MALE	Rabbit creek wpt22
24	8/10/2006	MALE	Ted Stevens Intl. Airport, "Sparky"(bearelectrocuted)
25	6/30/2006	MALE	Chenega Street, Stuckagain heights, Anchorage
200	5/8/2006	FEMALE	611 Chalet Dumpster, Elmendorf AF
200	7/17/2007	FEMALE	Bear 200 h7-59
200	8/2/2007	FEMALE	6 mile creek EAFB, wp25,bear 200
203	7/14/2006	MALE	N Fk Campbell creek, Ft Rich rub tree
203	7/24/2006	MALE	N. Fk Campbell Ck
203	8/10/2006	MALE	N. Fk Campbell Ck
204	7/22/2005	FEMALE	N. Fk Campbell Ck
204	8/3/2005	FEMALE	N. Fk Campbell Ck
204	8/3/2006	FEMALE	N. Fk Campbell Ck
204	7/31/2007	FEMALE	N. Fk Campbell Ck
204	8/13/2007	FEMALE	N. Fk Campbell Ck #10A
209	11/14/2005	MALE	Otter lake trail
29 individual bears		10 F; 19 M	20 different locations or occasions

Table 5 Individual brown bear distribution* and minimum population count determined from combining DNA samples and capture data (bear id shown)

Bicentennial Park /Campbell Tract	West of Glenn Highway on Military land	East of Glenn Highway on Military land	Eagle River Chugiak Bird Creek	Multiple areas	Total	Sex # bears
1					1	M
			2		2	F
3					3	M
4					4	F
5					5	F
		6			6	M
7					7	M
8					8	M
9					9	M
10					10	M
11					11	M
	12				12	M
13					13	M
			14		14	F
	15				15	M
			16		16	F
		17			17	F
18					18	M
		19			19	M
20					20	F
		21			21	M
		22			22	F
23					23	M
24					24	M
25					25	M
	200	200	200	200	26	F
			201		27	F
203		203		203	28	M
204		204		204	29	F
			205		30	F
			206		31	F
207		207		207	32	F
208		208		208	33	M
	209	209	209	209	34	M
		210			35	F
211	211	211		211	36	M
# bears 20	5	13	8	7		
# unique bears 15	2	6	6	7		

* Fifteen bears identified on military lands

Total individual bears 36 21M; 15F

Table 6 Diet Composition*

ID	Year Hair Collected	Year reflected in diet	Salmon (%)	Terrestrial Meat(%)	Vegetation & berries (%)
200	2005	2004	32	39	30
200	2006	2005	32	45	22
201	2005	2004	8	56	36
203	2005	2004	74	8	18
204	2005	2004	28	34	38
204	2006	2005	34	30	37
205	2005	2004	5	56	40
206	2005	2004	48	16	37
207	2005	2004	40	19	41
208	2005	2004	57	21	23
209	2005	2004	31	34	35
211	2006	2005	51	46	3
$\bar{x}$			37	34	30
SD			19	16	11

*Determined from ^{15}N and ^{13}C of hair
Hair reflects diet of previous year's growth